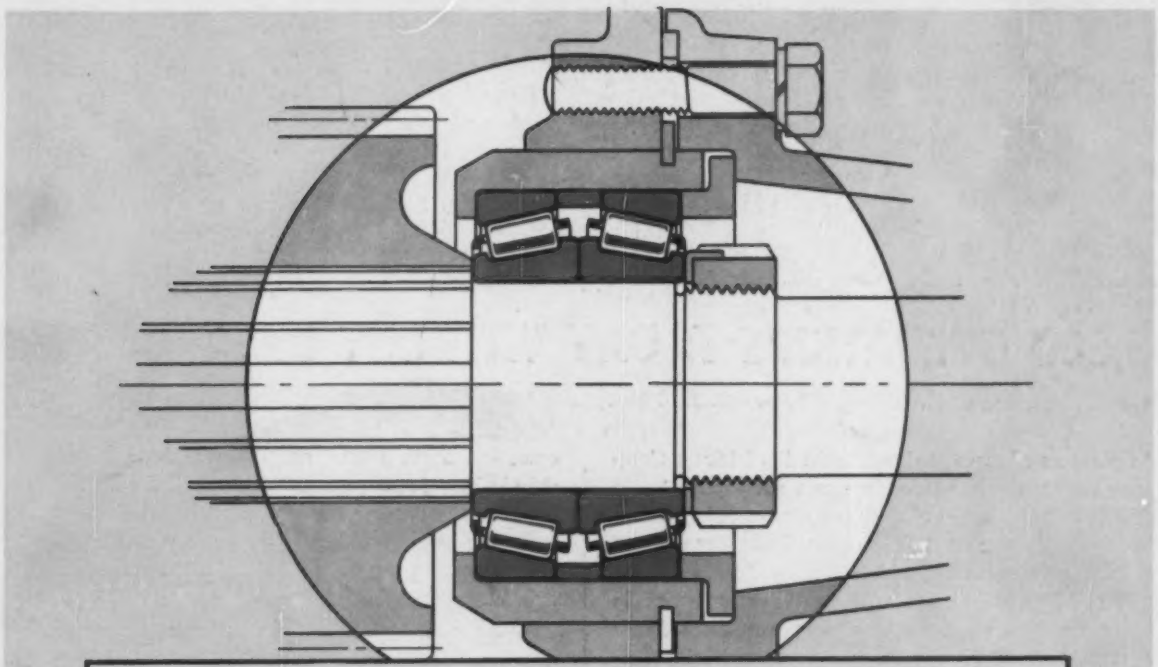
AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 48 No. 2 **FEBRUARY 1958** PRICE: 3s. 6d.



Rear bearing for a gearbox

The heavy thrust loads imposed in certain circumstances, via the propeller shaft, can best be resisted by Timken tapered-roller bearings, which also provide ample radial load capacity.

The drawing shows a pair of Timken bearings in this situation, with their pre-load controlled by a spacer supplied with the bearings, giving an arrangement which is proof against mal-adjustment.

TIMKEN Regd. Trade Mark: TIMKEN

tapered-roller bearings

MADE IN ENGLAND BY BRITISH TIMKEN LTD.

DUSTON NORTHAMPTON (HEAD OFFICE): DAVENTRY AND BIRMINGHAM

T.10

3,600 OPERATIONS A DAY WITHOUT BREAKDOWN!

Outstanding Performance of Atlas Copco Air Hoists at Ford's

As pioneers of mass-production, the Ford Motor Company utilises the latest developments and equipment in this field. An example of their progressive policy comes from the Ford works at Dagenham. There, for the past eighteen months, a number of *Atlas Copco* 8 cwt. air hoists, type MT 505, have been handling parts and materials in high temperatures and in atmospheres contaminated with dust and harmful chemicals.

Several Atlas Copco air hoists have been placed near the furnaces, both in the carburising plant and on the engine-block moulding line transferring the block from one conveyor belt to another. Despite the arduous conditions imposed by the furnaces, the hoists have made *3,600 journeys a day since their installation without a single breakdown or major overhaul.*

Motors completely protected

The reasons why Atlas Copco air hoists have continued to operate so efficiently under such conditions are these: the motors are totally enclosed and impervious to dust; there are no electrical insulations liable to attack by heat; the units are constantly lubricated by atomised oil entering the motors with the air stream. Because of this high degree of protection, an Atlas Copco air hoist was selected for operation above a tank containing trichlorethylene—a chemical de-greasing agent. In this application the hoist lifts metal parts requiring de-greasing into and out of the tank. The trichlorethylene fumes would soon disperse oil on the working parts of the hoist if it weren't for its unique lubrication system.

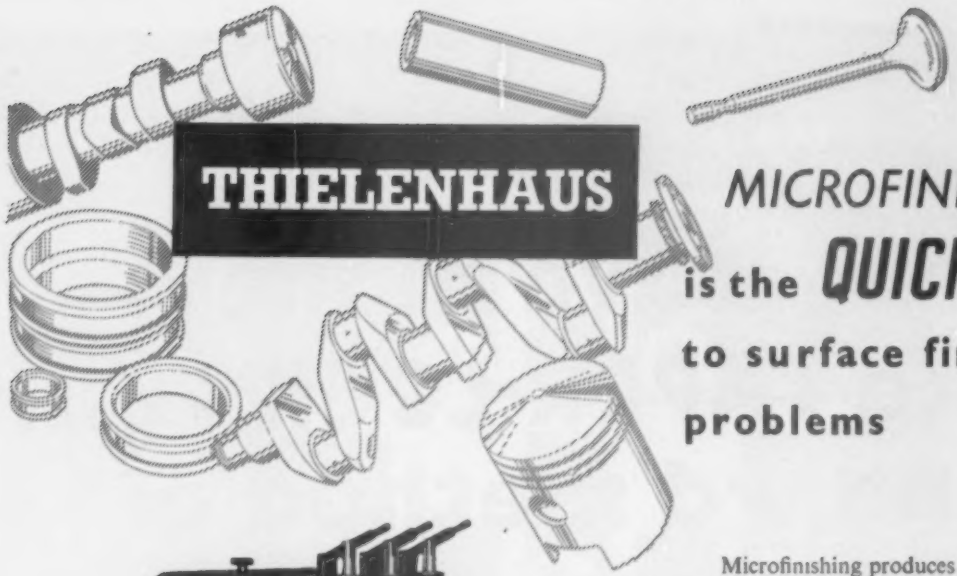
Due to their sound construction, so reducing maintenance to a minimum while operating over long periods under unfavourable conditions, Atlas Copco air hoists are contributing to increased production and efficiency at Dagenham—as they could in your works.

World-Wide Sales Service

The Atlas Copco Group puts compressed air to work for the world. It is the largest group of companies specialising solely in the development and manufacture of compressed air equipment. It embraces Atlas Copco companies or agents manufacturing or selling and servicing Atlas Copco equipment in ninety countries throughout the world. For further details of the equipment featured here, contact your local Atlas Copco Company or Agent. If you have any difficulty, please write to:— Atlas Copco AB, Stockholm 1, Sweden, or Atlas Copco (Great Britain) Ltd., Beresford Avenue, Wembley, Middx.

THE *Atlas Copco* GROUP OF COMPANIES

Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment



THIELENHAUS

MICROFINISHING

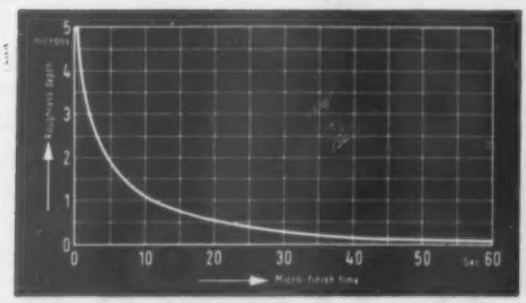
is the *QUICK* answer to surface finishing problems

Microfinishing produces smooth, high percentage bearing surfaces with sound crystalline base structure, greatly extending the life of highly stressed parts, which with production rates possible on Thielenhaus machines offers the two-fold gains of :

Improved functional quality and
Higher production.

This graph shows the relationship between surface roughness and microfinishing time. The rough surface of coarse peaks and valleys is quickly reduced and a roughness in the order of 12 M.I. (RMS) achieved in about 10 seconds. As the bearing portion increases so does the amount of material to be removed and the time required.

Roughness values between 1 and 2½ M.I. (RMS) can be produced on automobile crankshafts in a machining time of between 40 and 60 seconds.



The centreless machine illustrated is designed for small and medium sized components requiring either continuous or plunge-cut finishing. It is made in three sizes up to 5" dia. capacity. Thielenhaus machines are also available for micro-finishing crankshafts, camshafts, brake-drums, pistons, bearings and races, etc. A descriptive catalogue will be gladly sent on request.

WICKMAN LIMITED

FACTORED MACHINE DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY

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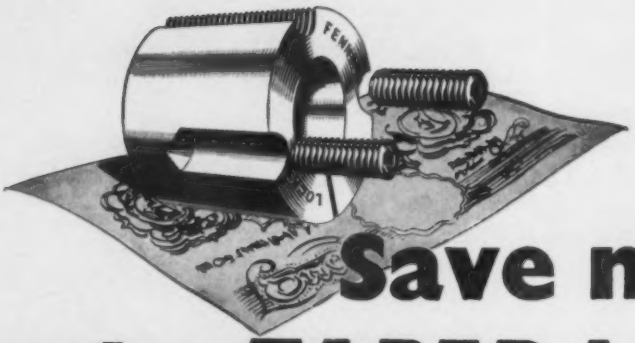
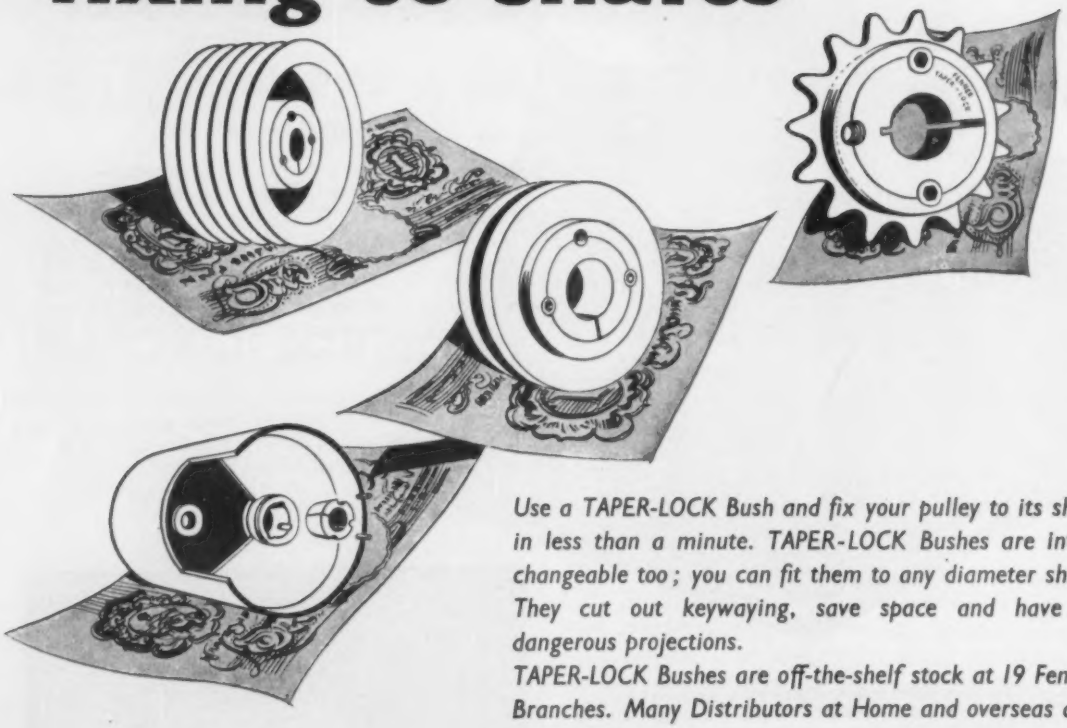


Save money—make TAPER-LOCK your standard method of fixing to shafts



Use a TAPER-LOCK Bush and fix your pulley to its shaft in less than a minute. TAPER-LOCK Bushes are interchangeable too; you can fit them to any diameter shaft. They cut out keywaying, save space and have no dangerous projections.

TAPER-LOCK Bushes are off-the-shelf stock at 19 Fenner Branches. Many Distributors at Home and overseas also stock them.

J · H · FENNER & CO · LTD · HULL

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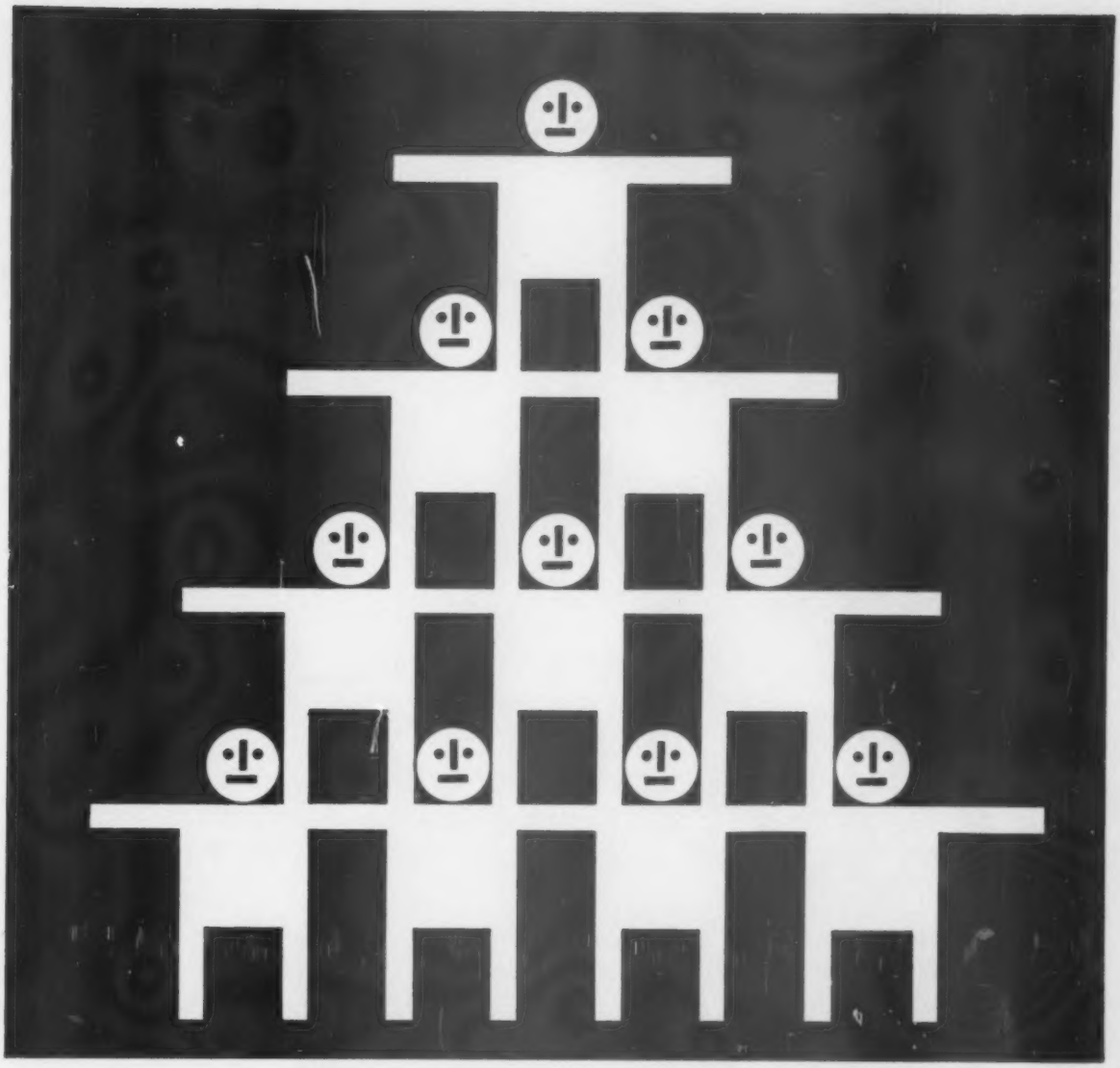
LARGEST MAKERS OF V-BELT DRIVES IN THE COMMONWEALTH



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Pretty good pyramid ..... we think so, but working as we are to the highest standards of precision every day, we tend to appreciate such things. If precision work (in thermo-setting plastics) is what you're looking for, plus the capacity to turn out a job bang on time, you'll be sure to find it with; Metropolitan Plastics Limited.

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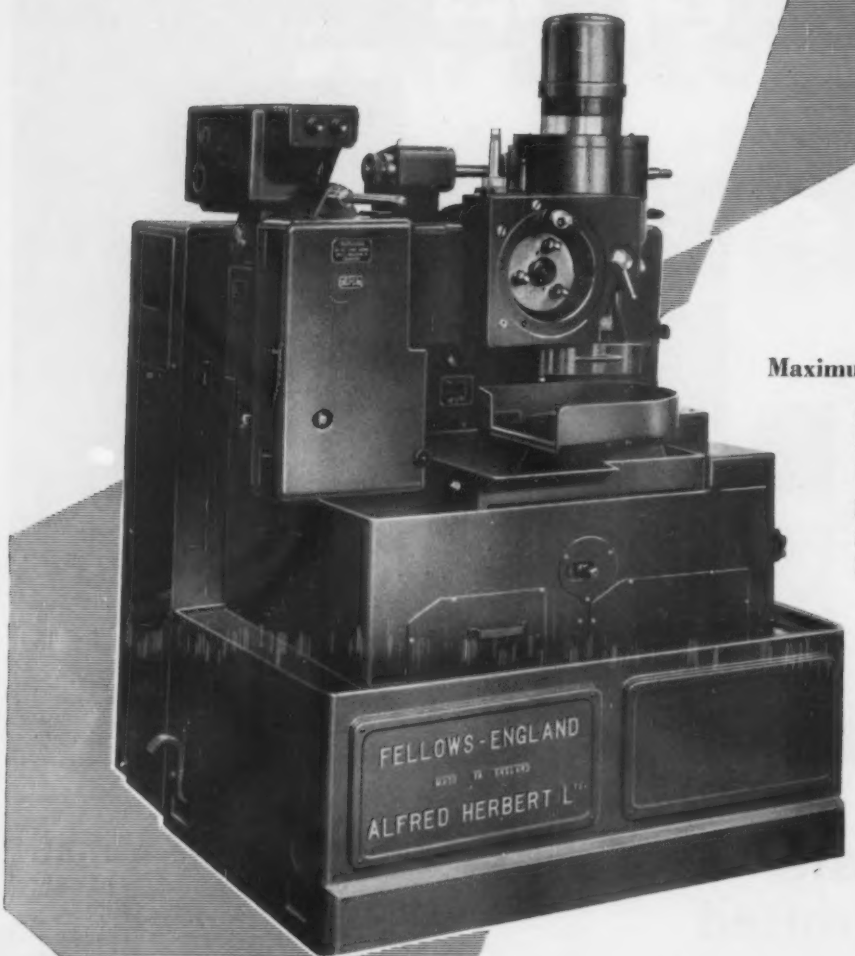
British-Built

Type 7125A Gear Shaper



Maximum pitch diameter cut:—

External
Spur —10″ at 10.D.P.
Helical—7″ at 6.D.P.

Internal
Spur and Helical } 6″ at 6.D.P.

Feed-cam trip mechanism to ensure accurate control of the amount of rotary over-travel of the cutter.

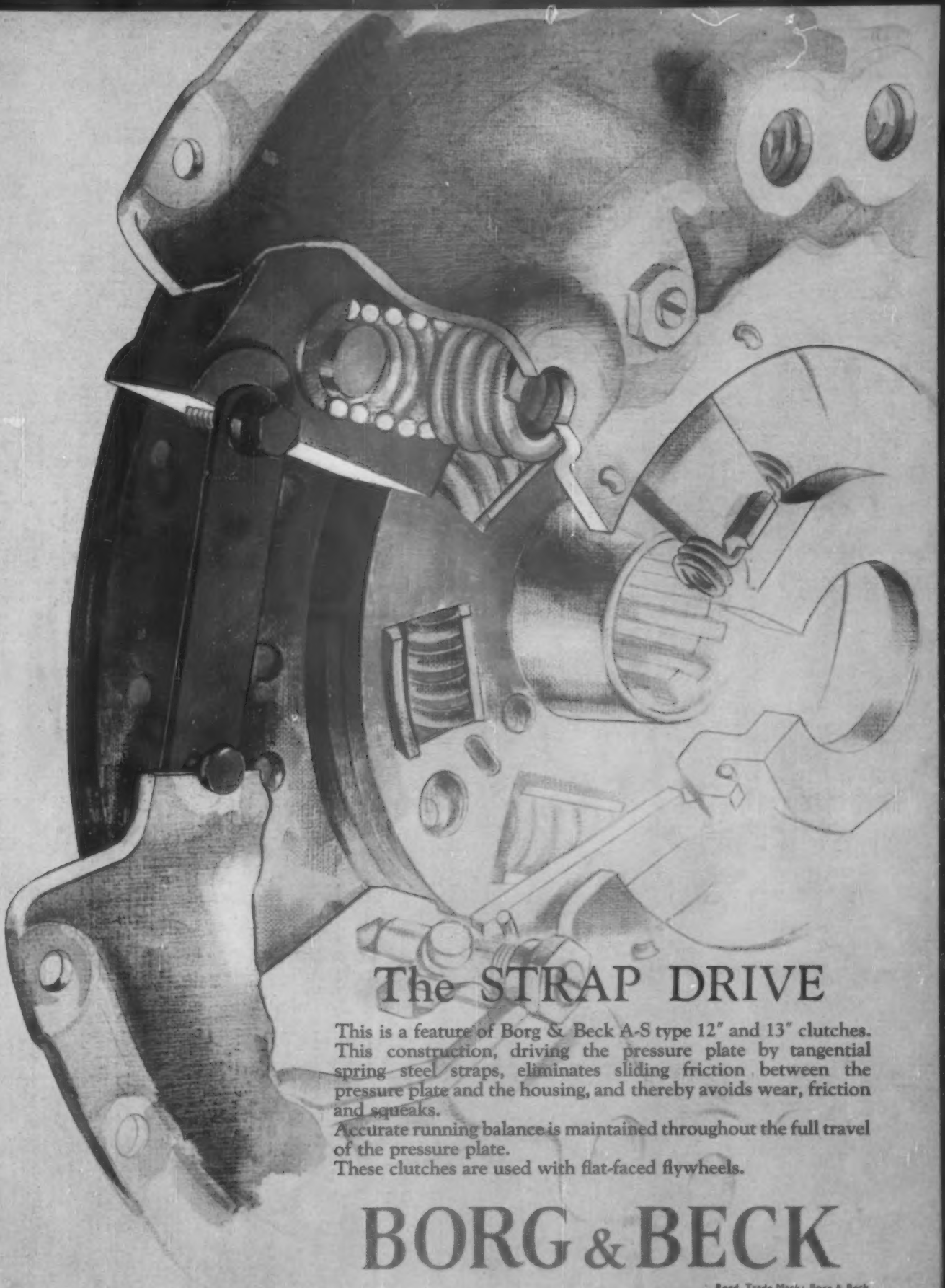
Motor drive and other electrics designed to suit market conditions.

Manual rotation for work check.

These and other features combine to produce a machine capable of high accuracy and consistent production.

ALFRED HERBERT LTD., COVENTRY — FACTORED DIVISION, RED LANE WORKS

AD.391



The STRAP DRIVE

This is a feature of Borg & Beck A-S type 12" and 13" clutches. This construction, driving the pressure plate by tangential spring steel straps, eliminates sliding friction between the pressure plate and the housing, and thereby avoids wear, friction and squeaks.

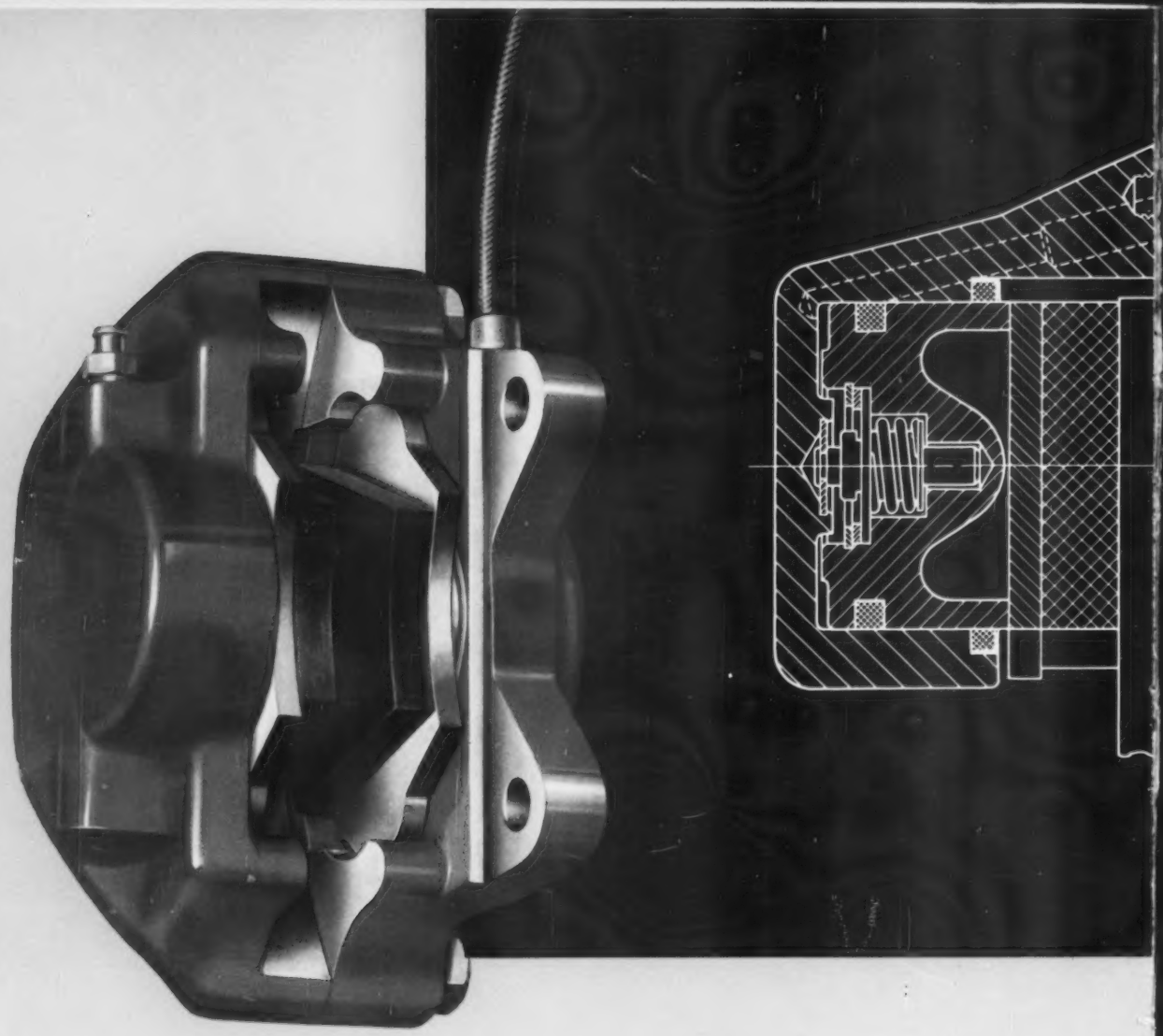
Accurate running balance is maintained throughout the full travel of the pressure plate.

These clutches are used with flat-faced flywheels.

BORG & BECK

Regd. Trade Mark: Borg & Beck

BORG & BECK COMPANY LTD. LEAMINGTON SPA, WARWICKSHIRE, ENGLAND



LOCKHEED *hydraulic* D

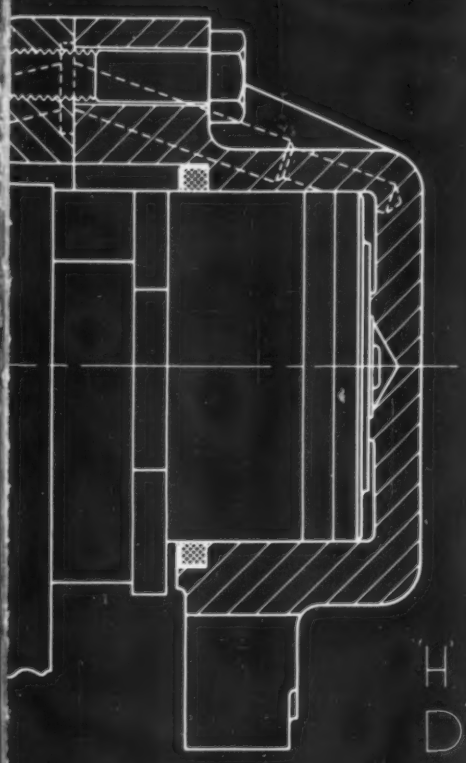
The two types, 'M & H' (medium and heavy), cover practically every requirement, with ample sized friction pads that give normal mileage without replacement.

The view of the brake on the left, shows on a reduced scale type 'M', for discs of 9½ to 11 in. dia.: the friction material is ⅜ in. thick, 5½ sq. in. area.

AUTOMOTIVE PRODUCTS COMPANY LIMITED

LEAMINGTON SPA, WARWICKSHIRE, ENGLAND

THE SAFEST DISC BRA



'H' TYPE
DISC BRAKE
(FULL SIZE)
Patents pending

GENERAL FEATURES

Automatic adjusters of the positive clearance type give constant brake pedal travel throughout the life of the friction pad.

Friction pads are easily changed without disturbing the hydraulic connections.

Reserve of brake lining is clearly visible.

Two pistons: each has a simple and effective Lockheed seal.

Pistons are well guided, and excellent arrangements are made for the exclusion of dirt, dust or water from the hydraulic equipment.

The internal fluid duct with one pressure seal eliminates the usual bridge pipe, and simplifies installation.

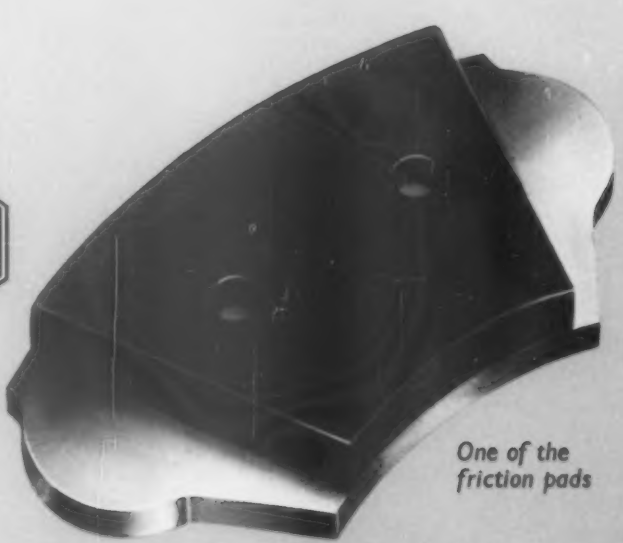
SC BRAKES

Type 'H', shown in the full size blue-print, for discs 10 to 12 in. dia., has friction pads ½ in. thick and 7¼ sq. in. area.

REGISTERED TRADE MARK
LOCKHEED

LOCKHEED

ES IN THE WORLD



One of the friction pads

PUROLATOR

Micronic OIL, FUEL & AIR FILTERS

PIONEERS OF SUCCESSFUL PAPER FILTRATION

AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON SPA, WARWICKSHIRE, ENGLAND

OERLIKON-*Spiromatic No. 2*

SPIRAL BEVEL GEAR GENERATORS, NORMAL & HYPOID

For the highest precision at mass production rates

Please ask for demonstration of this machine in actual production, or on your own blanks on our demonstration unit at our Nottingham demonstration rooms.

Simple and quick calculations and rapid setting. Operation by single lever. Crown wheels or pinions finished in one loading giving maximum production per capital expenditure with smallest floor space. Max. pitch dia.: 21.26″. Max. D.P.: 2½″. Max. length of cone: 10.33″. Number of teeth cut: 5-100.

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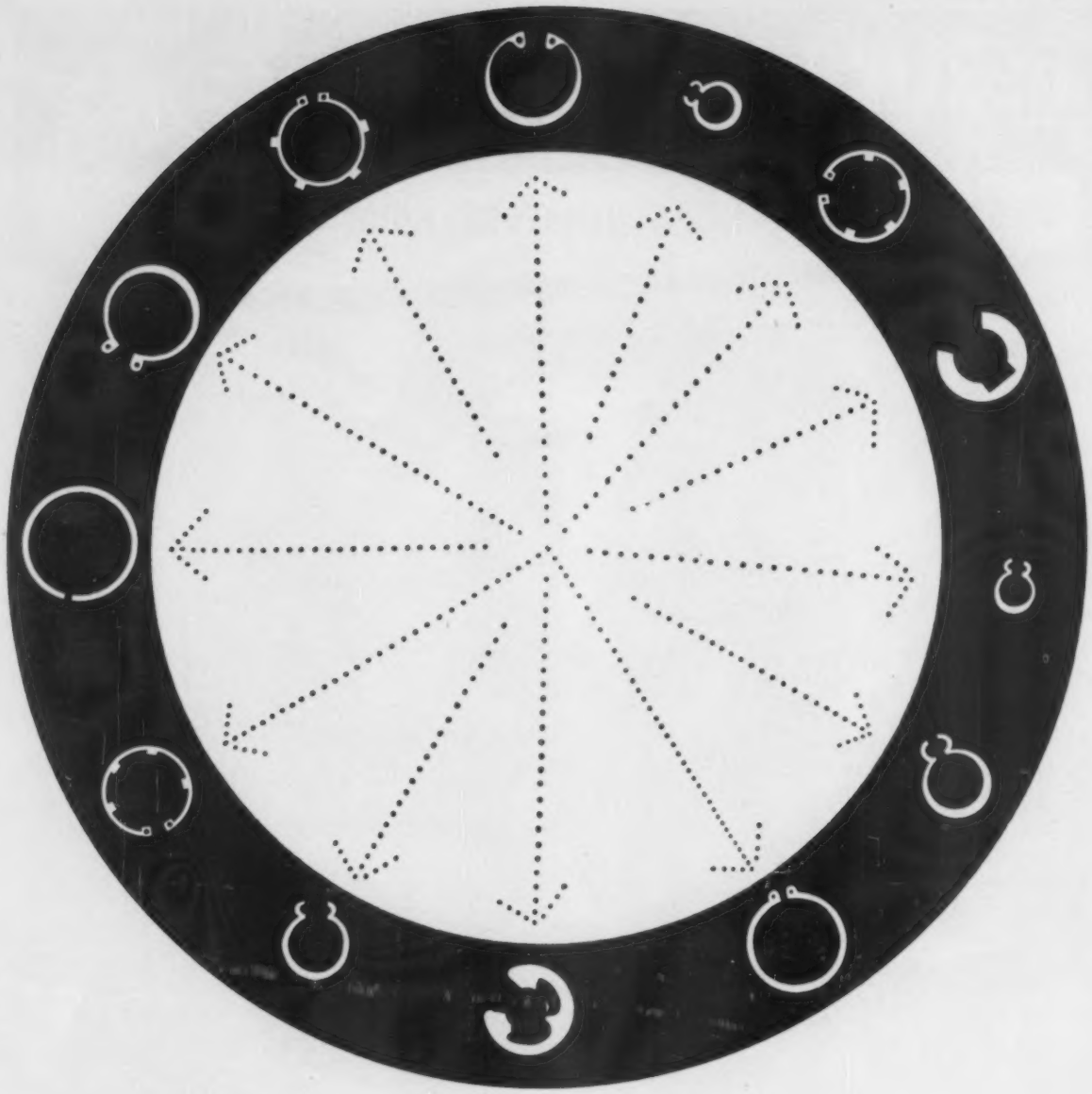

- **360° safe**
- **Consistent dimensions**
- **Constant Pressure**
- **A vast range of sizes**

That's why more people choose **SEEGER CIRCLIPS** *than any other make*

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One of the Sheepbridge Engineering Group
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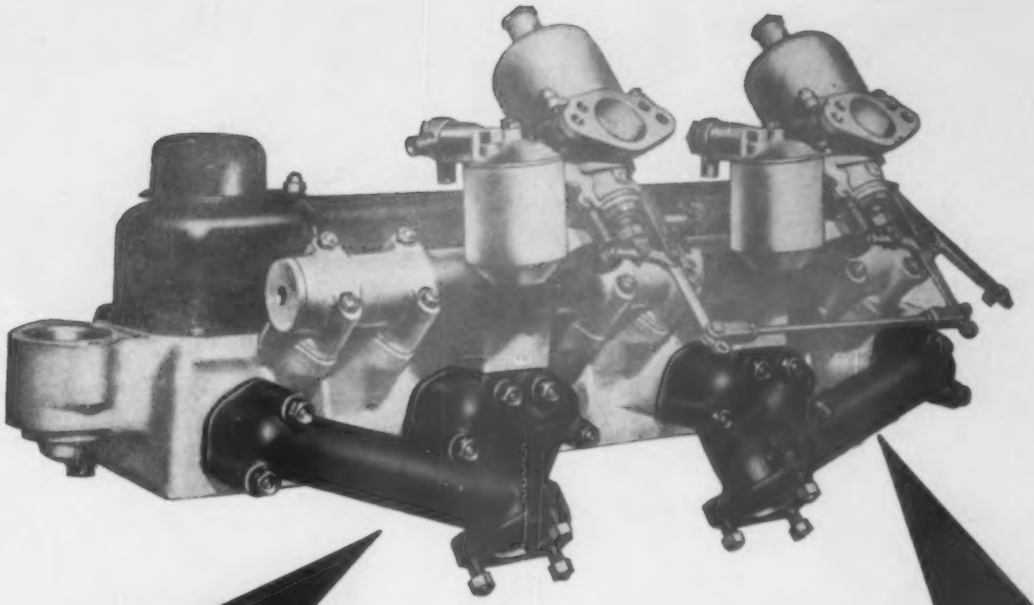

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RAYMOND MAYS ZEPHYR CONVERSION

Rubery Owen & Co. Ltd. chose Harper Castings for the exhaust manifolds of the Raymond Mays Cylinder Head Conversion because of their precision (especially the smoothness and accuracy of the internal passages), their strength and dimensional stability when exposed to hot gases, their freedom from porosity and their ready machineability.

If you require Castings needing any similar combination of physical and mechanical properties, Harper Castings can meet your needs.

Harper quality covers Grey Iron, Spheroidal Graphite Iron (Mond Nickel Licence) and Meehanite castings. Also Metal Pressings, machining, enamelling and other finishes and sub-assembly work.

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JOHN HARPER & CO. LTD. **JOHN HARPER** (MEEHANITE) **LTD.**
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H 647

what, no nuts? . . .

Nuts to use nuts? Well, not exactly, but the fact that the Tapping Screw obviates the use of nuts is just one of its distinct advantages over the conventional Machine Screw. There's the saving in time to consider too. And cost. And there's no doubt whatever that the tapping screw makes for a better job all round. With its self-locating point the tapping screw forms its own thread thereby eliminating a separate and expensive tapping operation. Obviously it makes for easier assembly, is stronger, cheaper and faster. Safer too when the Phillips recessed head is specified, designed for power driving without damage to worker or job. You'll be well advised to change over to Tapping Screws. Nothing nuts about that !

Linread

LINREAD LTD. COX ST. BIRMINGHAM 3

SLOTTED AND PHILLIPS RECESSED HEAD MACHINE SCREWS AND TAPPING SCREWS • HIGH TENSILE HEXAGON HEAD BOLTS AND SETSCREWS AIRCRAFT BOLTS, SCREWS AND RIVETS • SEMS • RIVNUTS • CUSTOM DESIGNED COLD FORGED FASTENERS • ALEX SCREWPLUGS.

TRAILING-LINK FLEXIBLE couplings

The Metalastik Trailing Link Coupling is one of the most compact forms of coupling and occupies the minimum of axial length in relation to the parallel misalignment accommodated. It also takes care of angular misalignment and end float while cushioning shock loads and smoothing out torque irregularities. It has a high capacity for occasional overloads.

In the drive from gearbox to three-cylinder air-compressor on a Scammell road tanker, as illustrated, a Trailing Link Coupling transmits a torque of 2,250 lb./ins.

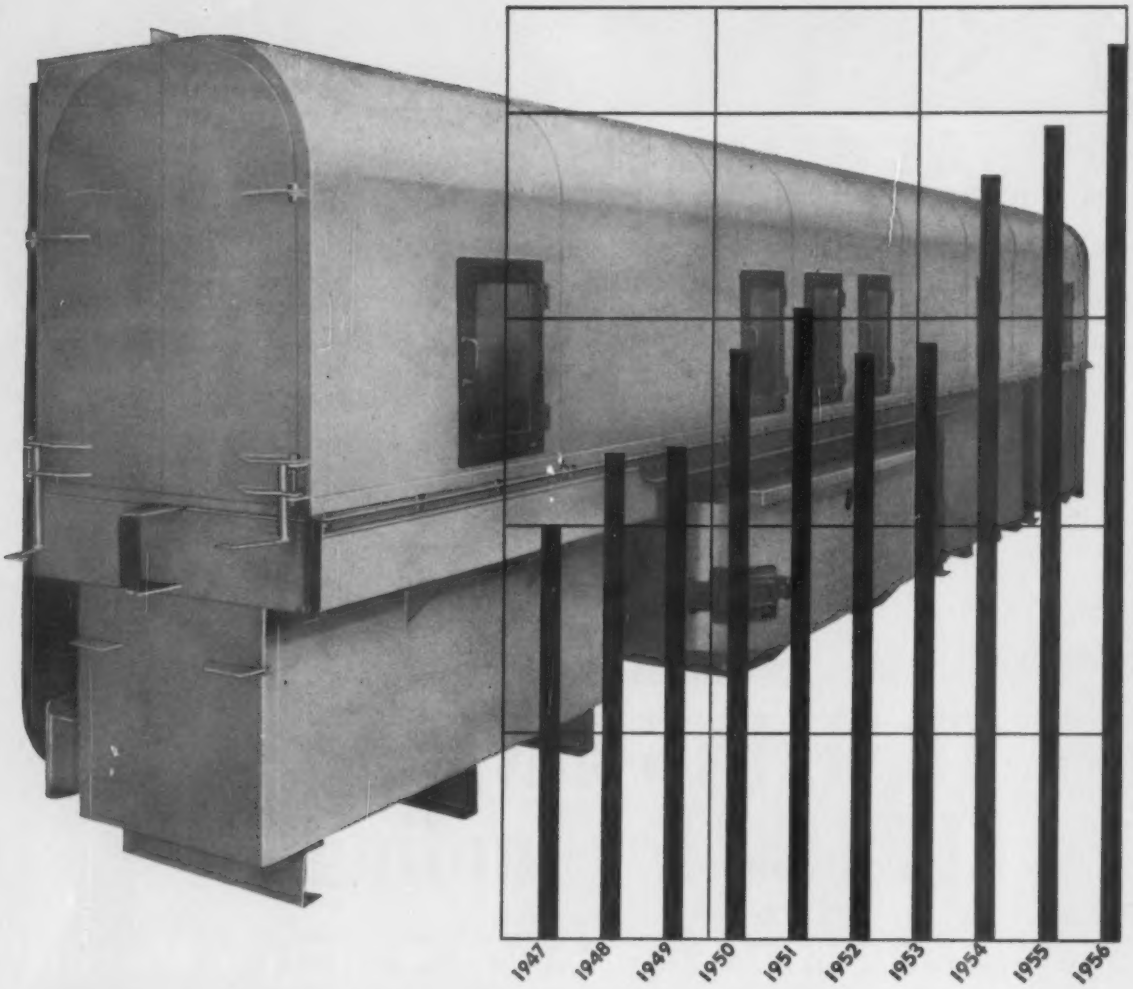
The small illustration shows the famous Metalastik Ultra-Duty Bush which takes movement in the links of the coupling.

METALASTIK

METALASTIK LTD. LEICESTER

For main as well as auxiliary drives, Trailing Link Couplings are manufactured in a range of sizes to transmit 1-20 h.p. at 100 r.p.m.

Hard Facts



SOME PEOPLE say that "the salt bath method of casehardening is a back number". Well, our sales of 'Cassel' carburising salts have been rising spectacularly over the last ten years. Look at the graph—it speaks for itself. Last year we sold more 'Cassel' salts than we'd ever done before; and it wasn't just that existing customers were using more — we had many *new* customers last year. So there it is: for a "back number", the salt bath method seems to be doing pretty well. It's not surprising — the salt bath method gives you simplicity of control and high metallurgical quality. And we like to think we have something to do with its evergrowing popularity — after all, you can't do better than

'Cassel' Salts for Casehardening

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1.

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MARLES type 4 power-steering gear

This latest type 4 unit embodies the wide experience of Marles in power-steering, and consists of a 2-valve box mounted on the top of the standard Marles 861 manual gear unit.

The type 4 unit, the Universal unit and the standard manual unit are all interchangeable on the same mountings.

Further particulars will be sent on request.

ADAMANT ENGINEERING CO. LTD., DALLOW ROAD, LUTON

Sole proprietors of the Marles Steering Company Ltd.

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The position of leadership entails responsibility, and the Ferodo organisation is forever experimenting, improving and developing so that they may rightly claim FERODO WILL ALWAYS BE FIRST.

Ferodo Limited · Chapel-en-le-Frith

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FERODO

Ferodo will always be first

Ferodo Limited are the largest manufacturers of brake linings in the British Commonwealth. They have, over the years, been the first to develop and introduce such *major improvements in brake lining technique as asbestos based materials, die pressing, moulded materials, and non-wire woven materials.* The Ferodo Laboratories and Test House, unique in scope and application, are constantly engaged in testing and developing new materials and methods, keeping always a step ahead of higher speeds and mechanical developments.

Ferodo Linings are fitted as first equipment to more makes of vehicles than all other Brake Linings combined

The choice of Ferodo by this majority of Automobile Manufacturers emphasises the confidence placed in them, after the most stringent tests, by the motor industry.

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Deep in the heart of the Central American jungles are hidden temples of a long-lost civilisation—gems of architecture which have successfully withstood the test of time.

And deep in the heart of the world's finest car engines another treasure is hidden . . . silent . . . enduring . . . vital . . . a ***Renold Timing Chain.*** *It's a gem of a chain—smooth running and flexible, capable of innumerable driving arrangements and outliving the engine itself.*

RENOLD TIMING CHAINS

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RENOLD—*the FIRST name in precision chain*

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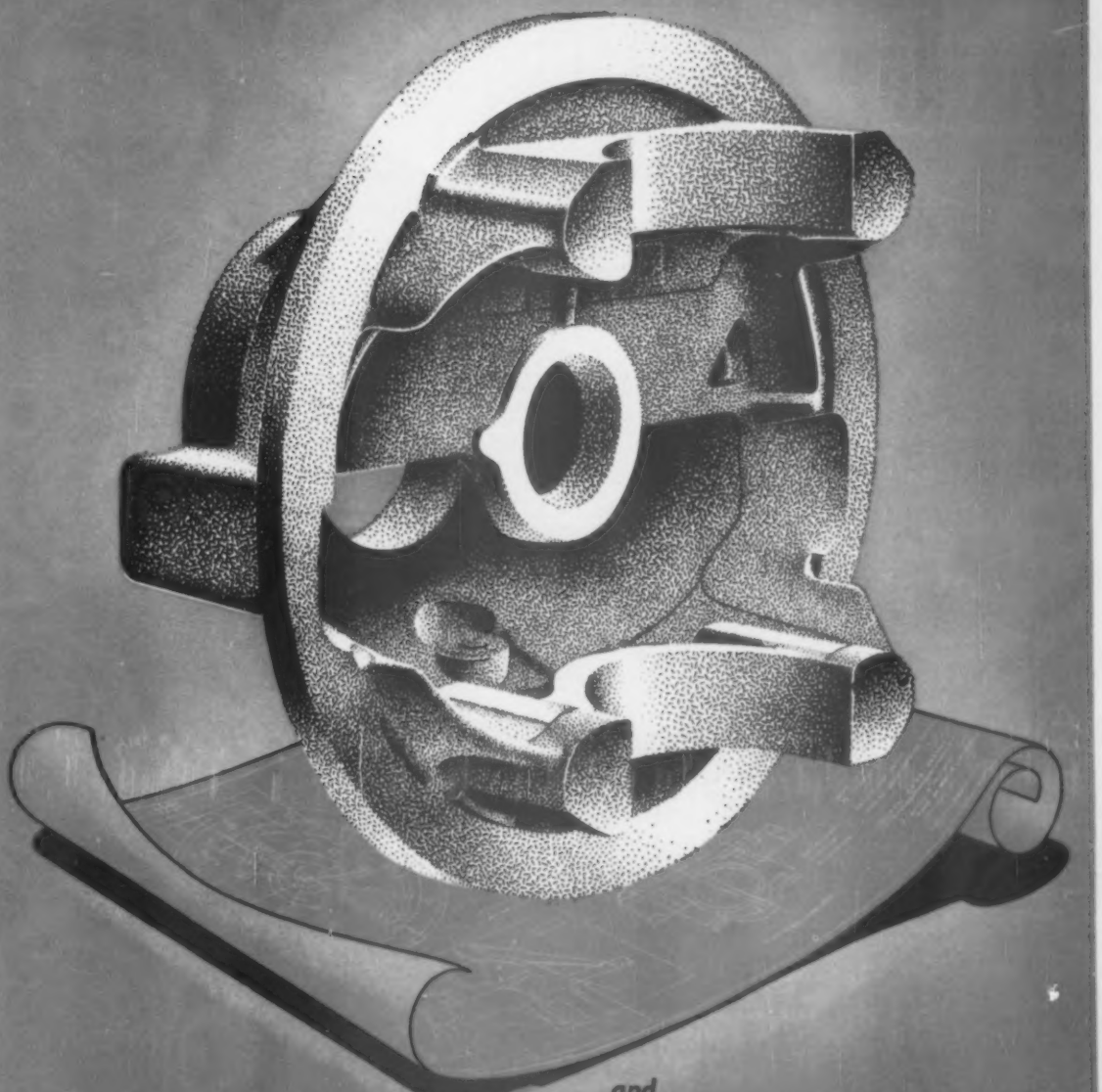
BETTER BLACKHEART MALLEABLE IRON CASTINGS

Backed by 60 years experience and technique



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"HARDANTUF" PEARLITIC MALLEABLE CASTINGS

SHOTTON BROS. LTD., OLDBURY Nr. BIRMINGHAM. Tel: BROadwell 1631-2

We are now booking capacity for our New Modern Foundry at Halesowen

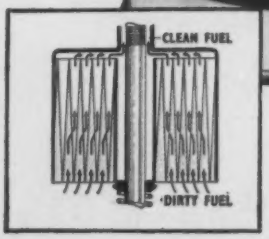
What happens inside?

If you cut open the container of a used C.A.V. type 'F' fuel filter, remove the paper element and slice it through, you will see the sludge and dirt which has been prevented from reaching the high precision components of the fuel injection equipment.

The element is of spiral vee-form construction, the paper being crêped to provide continuous space between adjacent turns. Dirty fuel is confined to the underside of the paper coil, and filtered fuel to the upper side. The filtering surface is 560 square inches—much greater than that of other types of comparable size, so that a large volume of fuel can be filtered without choking.

The paper used has been most carefully selected and is specially manufactured for the job. It is resin-treated, and of high strength when wet. Paper elements have been subjected to boiling, low temperature, severe vibration and pressure tests, without harmful effect. Most important of all, the paper effectively removes from fuel oil particles of a size which would cause most damage and wear to pump barrels and plungers.

In laboratory tests the new filter gave *over six times* the life of pump elements obtained with a cloth filter.



C.A.V. type 'F' fuel oil filter

The World's Leading Manufacturers of

FUEL INJECTION EQUIPMENT

C.A.V. LIMITED, ACTON, LONDON, W.3

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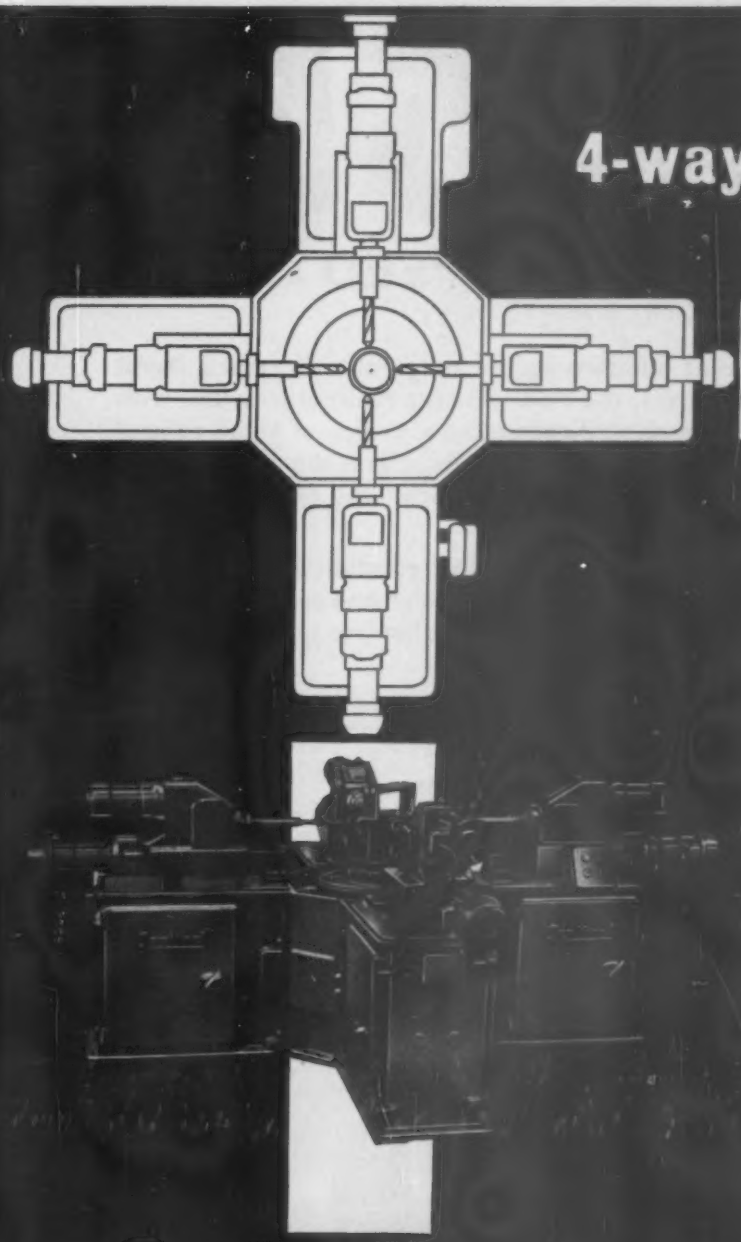


4-way economy

with

Sentinel

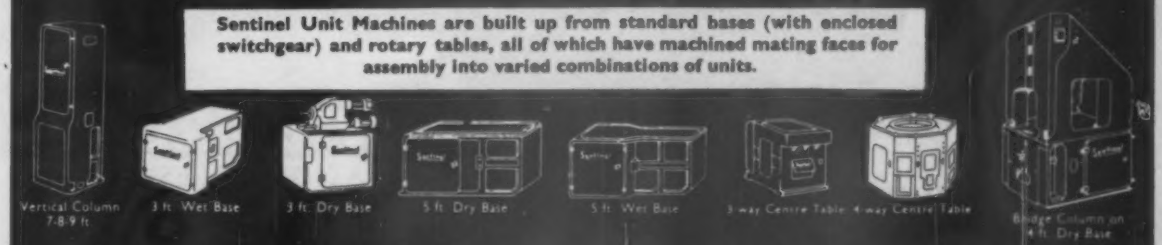
unit machines incorporating the Renault-France system electro-mechanical head

An example of cost cutting and output raising can be seen at Ford Motor Company, Dagenham. Here is a Sentinel 4-Unit machine for performing "Drill-Ream" operations on differential cases.

The heads are slide-mounted, horizontally, vertically or at angles on a wide range of standard columns and bases. Delivery is normally ex-stock. Time, cost and quality, on almost every machining operation can be greatly improved using Sentinel Unit Machines.

Sentinel ***adaptability — versatility — flexibility***

Sentinel Unit Machines are built up from standard bases (with enclosed switchgear) and rotary tables, all of which have machined mating faces for assembly into varied combinations of units.


Vertical Column 7-8-9 ft
3 ft. Wet Base
3 ft. Dry Base
5 ft. Dry Base
5 ft. Wet Base
3-way Centre Table
4-way Centre Table
Bridge Column on 4 ft. Dry Base

SENTINEL (SHREWSBURY) LTD SHREWSBURY ENGLAND

Telephone: SHREWSBURY 2011 Telegrams: "SENTNOLL SHREWSBURY" London Office: 15 Conduit Street LONDON W.1 Telephone: MAYFAIR 2675

DAVID BROWN

new 552

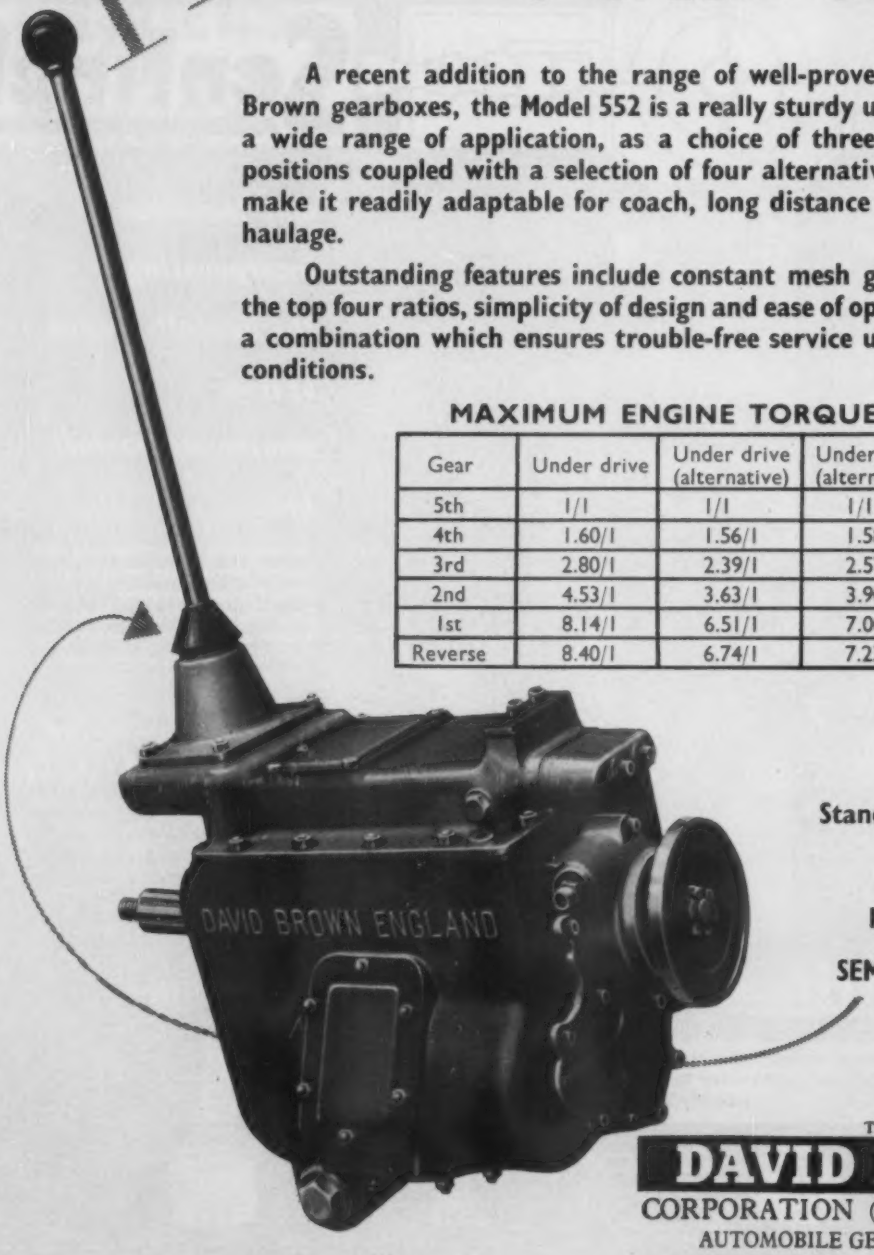
5 SPEED GEARBOX

A recent addition to the range of well-proved David Brown gearboxes, the Model 552 is a really sturdy unit with a wide range of application, as a choice of three control positions coupled with a selection of four alternative ratios make it readily adaptable for coach, long distance or local haulage.

Outstanding features include constant mesh gears for the top four ratios, simplicity of design and ease of operation, a combination which ensures trouble-free service under all conditions.

MAXIMUM ENGINE TORQUE 250 lb. ft.

Gear	Under drive	Under drive (alternative)	Under drive (alternative)	Overdrive
5th	1/1	1/1	1/1	0.76/1
4th	1.60/1	1.56/1	1.58/1	1/1
3rd	2.80/1	2.39/1	2.57/1	1.84/1
2nd	4.53/1	3.63/1	3.90/1	3.63/1
1st	8.14/1	6.51/1	7.00/1	6.52/1
Reverse	8.40/1	6.74/1	7.23/1	6.71/1



Standard Controls

CENTRE

FORWARD

SEMI-FORWARD

THE

DAVID BROWN

CORPORATION (SALES) LIMITED

AUTOMOBILE GEARBOX DIVISION

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assembly lubricants that "stay put"

On motor-car engines—and other mechanical equipment—oil films tend to run from bearing surfaces during the period of immobility between assembly and running-in. A **'dag'** dispersion of colloidal graphite applied initially provides all bearing surfaces with a protective graphite film which will "stay put" during the critical starting-up and running-in stages.

Illustration shows ***'dag'*** *colloidal graphite being applied during engine-assembly at the works of the Standard Motor Co. Ltd., Coventry.*

dag
REG. TRADE MARK
DISPERSIONS
colloidal graphite

ACHESON COLLOIDS LTD
(subsidiary of Acheson Industries (Europe) Ltd.)
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The TRADITION *behind* MIDCYL

"Spot on"

More than thirty years ago, Midcyl pioneered a system of inspection which has become traditional in the trade — today 'spot location' is still relied on as a most efficient method of assuring that all castings conform dimensionally to customers' requirements.

THE MIDLAND MOTOR CYLINDER CO. LTD., SMETHWICK, STAFFS.

GACO
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GACO
GEORGE ANGUS & Co LTD
OIL SEAL DIVISION
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universal
steel & metal
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Morleys
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Regina Works, Alcester Street, Birmingham, 12
Telephone: MIDland 6346 (6 lines) Telegrams "Capable, Birmingham"
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London, E4
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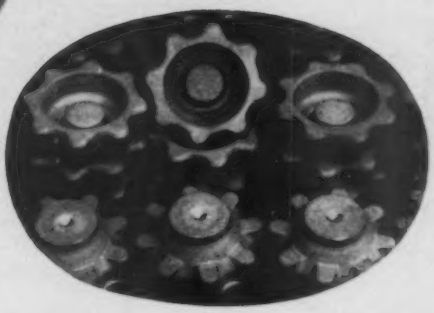
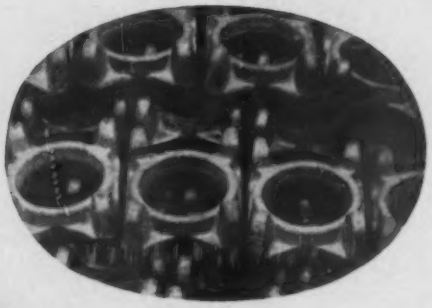
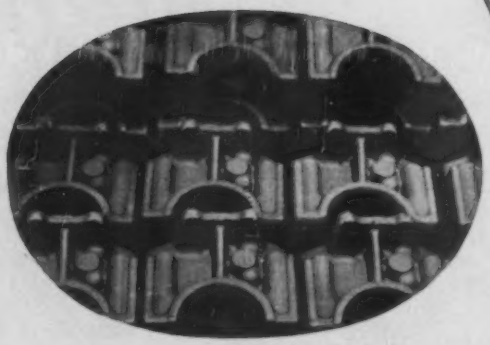
MAKE A NOTE OF THE NAME
YOU'LL DO BETTER AT Morleys (B'HAM) LTD.



Drop Forgings





DONCASTERS ◇ 1778 D D

Talk to engineers
about drop forgings and they think of
Daniel Doncaster & Sons Ltd.
Whether it be the aircraft industry,
the motor industry or
any other user of drop forgings,
all agree that "for drop forgings
of top quality, in large or
small quantities, it is best to go
to Doncasters."

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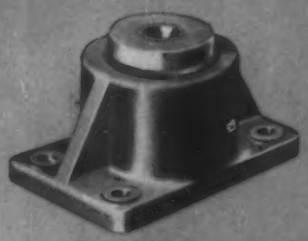
FS2

General type (triangular flange)

Pedestal assembly



Pedestal mounting

Frustacon type

FN type

Instrument type (pedestal flange)

Instrument type (square flange)

Ring-stud mounting

Bonded stud mounting

VIBRATION-FREE

'SILENTBLOC' rubber-metal mountings are the accepted means of insulating almost anything from vibration—from small and delicate instruments to multi-ton drop-hammers. If you have a vibration problem, bring it to us as pioneers and far and away the leaders in the use of rubber in engineering. Technical information always available from *Silentbloc Limited, Manor Royal, Crawley, Sussex. Telephone: Crawley 2100.*

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Pioneers of Rubber in Engineering

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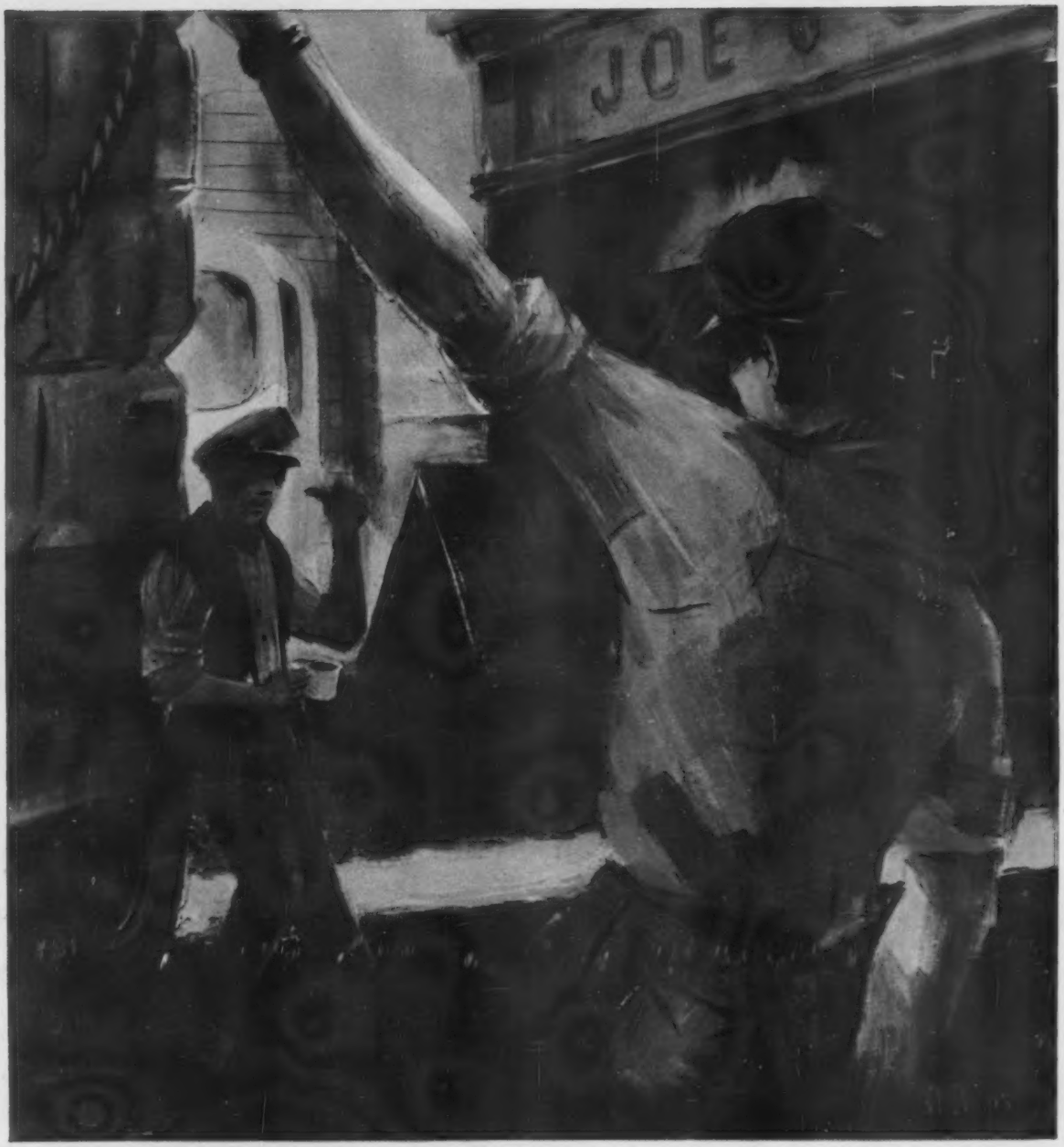

"Since the speed limit's been raised...

. . . you soon notice if your brakes aren't up to it — especially on a heavy truck like this. My firm always specify 'Clayton Dewandre' braking equipment — they know there's none better!"

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AP34

A-MP TRADE MARK modern solderless terminations

for every automotive application

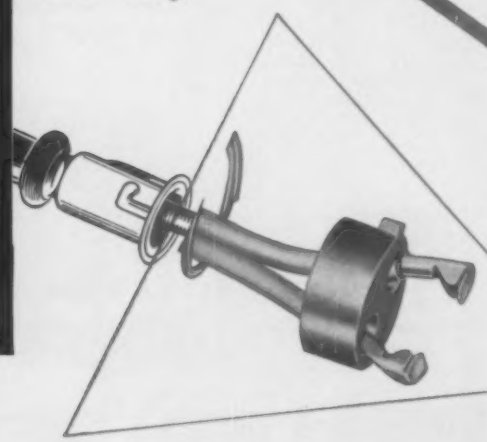
Wherever there is a wire
there is an **A-MP*** Solderless Terminal to connect it.

- Top electrical and mechanical performance.
- The pressure-crimp eliminates the necessity for soldering and welding.
- **A-MP** automatic machines crimp up to 4000 uniform terminations per hour.
- Adopted by American car and truck manufacturers.

Investigate the advantages of **A-MP** creative approach to Better Wiring.

A-MP SYSTEMS AID EXPORTS

The A-MP solderless method meets wire termination specifications in foreign countries. Use of the A-MP method will enable you to compete in world markets. It is particularly significant that A-MP systems are standard practice in the U.S.A.



This **A-MP** solderless Button Contact, specially designed for automotive light sockets is made in strip terminal form and supplied on reels for automatic machine application. High-speed automated terminations ensure uniform high quality and reduce costs.

A-MP* TRADE MARK

AIRCRAFT-MARINE PRODUCTS (GT. BRITAIN) LTD.

London Office: DEPT. 12, 60 KINGLY STREET, LONDON, W.1. Telephone: REGENT 2517-8 and 3681-2-3

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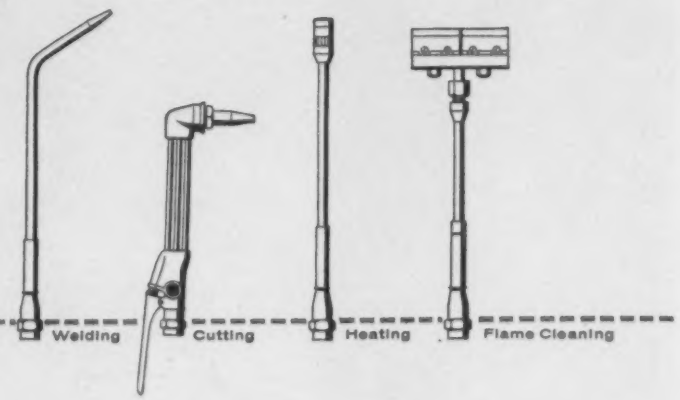
*Trade Mark of AMP Incorporated, U.S.A.

AP 323-49

FROM BRITISH OXYGEN — FOR BRITISH INDUSTRY



Sensational Saffire 4 blowpipes in 1!

Common Shank to which any of these blowpipes can be fitted.

Recently introduced, the Saffire Combined Outfit has achieved outstanding success and widespread use in industry.

The Saffire, virtually 4 blowpipes in 1, is extremely efficient and economical in use. Here is a precision tool that has helped boost production for many thousands of users.

Buy the whole Saffire Outfit or just the common shank with the heads you need. Just consider how the Saffire Combined Outfit can increase *your own* production range and efficiency!

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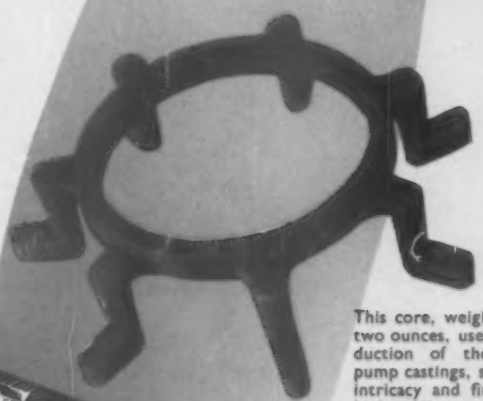
WHEN SAFETY MEANS SO MUCH

P·B·M CASTINGS ARE USED ...

No vehicles make more constant use of braking power than Public Transport. That's why, when constant reliability is so vital, P·B·M Aluminium castings are specified by Lockheed for the hydraulic pump on their famous power-operated brakes in use on the buses of Midland Red Motor Services—one of the largest services in the country.



This core, weighing less than two ounces, used in the production of these hydraulic pump castings, symbolises the intricacy and fineness of this high quality production.

PBM GRAVITY DIECASTINGS

MACHINED CASTINGS & ASSEMBLIES . . .

P·B·M have excellent facilities for supplying castings as fully machined and assembled components.

PERRY BARR METAL COMPANY LTD., GREAT BARR, BIRMINGHAM 22A

TELEPHONE: GREAT BARR 1794-5-6

I gather Ransome & Marles have a substantial export trade?

Yes. Business overseas has been done for many years through agents and subsidiary companies. Among our biggest customers are many of the newly industrialised countries in Africa and the Far East—countries which are now equipping themselves with machinery at an enormous rate. We also export our bearings to the established industrial areas—to Europe and North America—where our products enjoy a long record of first-class service.

You have, of course, a worldwide network of agents to support this export trade?

We have indeed. Something like eighty agency offices throughout the world. We are concerned, mainly, with providing an unrivalled on-the-spot service for overseas industry. Firstly, we produce bearings that will stand up to arduous conditions of work in every climate. Secondly, local users are thoroughly informed about all the factors affecting the actual running of the bearings. Thirdly, the purchaser is safeguarded with after-sales service. These are our obligations to the foreign manufacturer. I think it is fair to say that we meet them very successfully, because we are constantly expanding our export business and shall continue to do so in the future.

RANSOME & MARLES BEARING CO. LTD • NEWARK-ON-TRENT • ENGLAND

TELEPHONE • NEWARK 456 AND TELEX 37-306

NEW ANDRE AIR SPRINGS FOR COMMERCIAL AND PASSENGER VEHICLES

The Andre Air Spring consists of two simply installed Air Pillows, one each side of the vehicle, whether single or tandem axle arrangement, but they can also be fitted in wishbone suspension arrangements or independent trailing arm suspensions. The pressure is maintained in the Pillows from the vehicle air brake system, or from a separate compressor when air brakes are not fitted. The suspension assembly can be arranged with rubber bushing so as to eliminate all lubricating points.

AUTOMATIC LEVELLING

A suspension incorporating Andre Air Springs and levelling valves assures that the floor of the vehicle is always parallel to the axle, thus uneven loading and severe crown road conditions etc. are overcome, giving a more pleasant and easy ride for the driver. For Passenger Vehicles step heights remain constant irrespective of load.

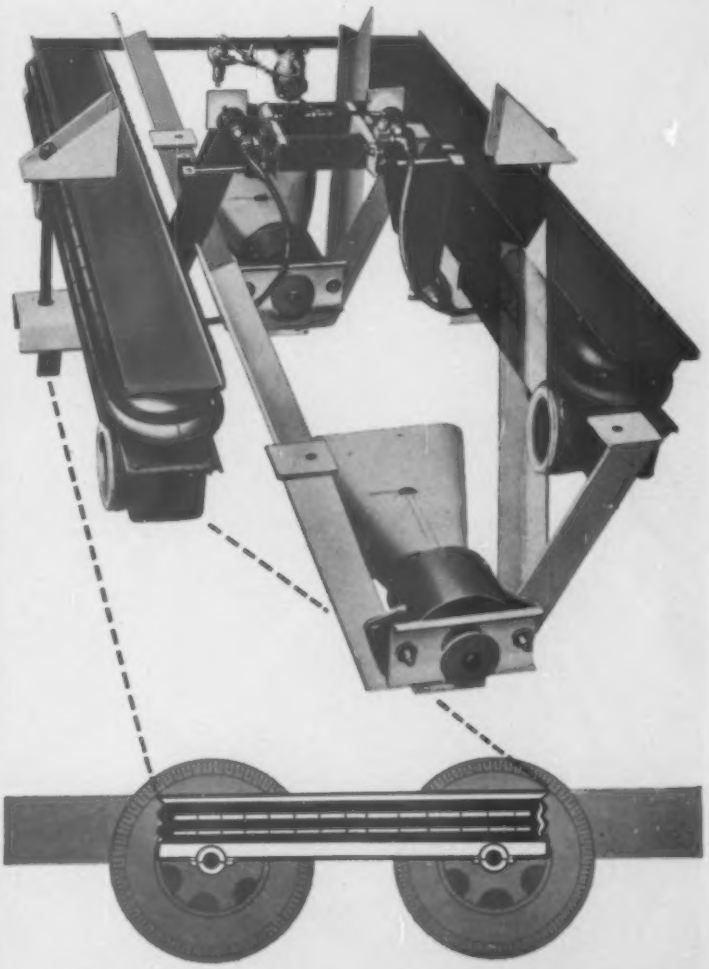
ALWAYS THE SAME RIDE WHETHER LIGHT OR LADEN VEHICLE

A feature of air springing is that, due to the action of the levelling valves, the position on the load deflection graph remains constant irrespective of load; consequently the frequency remains the same for all conditions of service. This also has the effect of eliminating bouncing due to resonance conditions, thus reducing maintenance not only of the suspension but chassis and body. It also affords greater protection for the goods or passengers being carried.

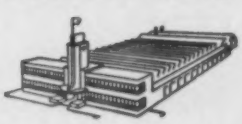
INCREASED SAFETY

This ideal suspension gives greater tyre life.

We invite you to approach us with your problems, when we shall be pleased to co-operate with you on all technical matters appertaining to this great new advance in suspension systems.



Three-and-a-half acres of specialised Rubber Technology.



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ANDRE RUBBER

ANDRE RUBBER COMPANY LIMITED

KINGSTON BY-PASS, SURBITON, SURREY

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(A SILENTBLOC COMPANY)

✳ THE VICE BUILT AS A MACHINE TOOL...

Expensive machine tools deserve a machine vice of equal precision—a role befitting the precision built DOWN-GRIP vice. Laborious setting-up time is substantially reduced. The quick action jaw slides right up to the job—a slight turn of the screw then gives instant and positive downward grip!

This vice has its own hardened and ground steel table, parallel to the base, providing a permanent foundation for precision work.

By simply pressing the thumb-triggers the movable jaw is entirely free to slide, thereby eliminating time wasted adjusting the normal machine vice.

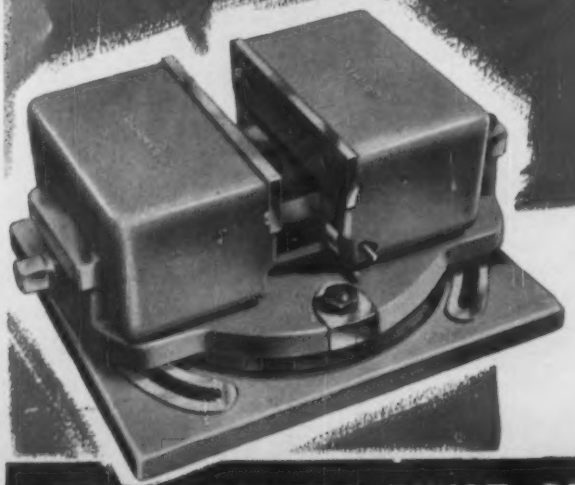
Hardened steel jaws are fitted as standard but soft jaws are available.

Vice swivels on base through 360°

Reversible jaw plates for irregular shapes.

Standard range includes 4", 6" and 8" jaw widths.

✳ THE DORMER **DOWN GRIP**



A NEW AND FASTER MACHINE VICE
. . definitely holds the job down!

THE SHEFFIELD TWIST DRILL AND STEEL CO. LTD.
SHEFFIELD ENGLAND

DORMER MACHINE VICES ARE AVAILABLE FROM YOUR USUAL ENGINEERS' MERCHANTS

Versatile —Powerful

—for heavy duty on a wide range of work

Archdale 34" VERTICAL

REVERSIBLE AUTOMATIC FEEDS AND QUICK POWER TRAVERSE IN THREE DIRECTIONS

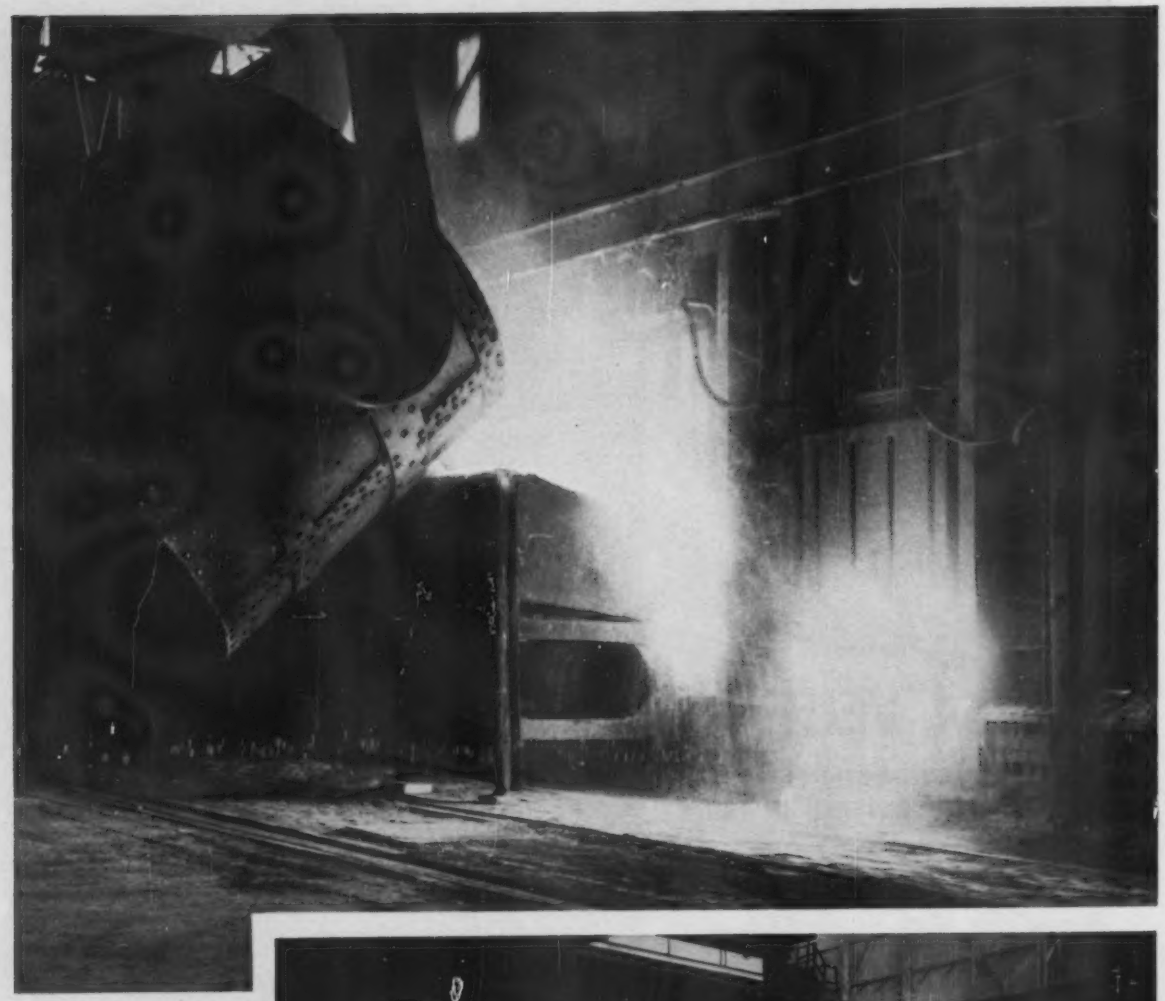
The characteristic power and rigidity of the 34" Vertical Milling Machine is demonstrated to good effect when taking a ¼" cut at 3½" per minute on this 4% carbon steel billet. This machine is installed at Geo. Swift & Sons Ltd., who find its great versatility invaluable in producing a wide range of machine tool components. All 12 feeds and spindle speeds are selected from the front of the machine, the speeds ranging from 29—520 or 36—638 R.P.M., and the feeds ⅜" to 20" per minute.

JAMES ARCHDALE & CO., LTD.

BIRMINGHAM 16 · SOLE SELLING AGENTS · ALFRED HERBERT LTD. COVENTRY

A member of the Staveley Coal & Iron Co., Ltd. Group.

One-third of Britain's SHEET STEEL



Molten iron being charged into an open hearth furnace at Abbey Works

The ingot stripper bay at Abbey Works

ENQUIRIES

to The Sales Manager:
Sheet and Plate—
Abbey Works,
Port Talbot,
Glamorgan.
Electrical Sheet—
Orb Works,
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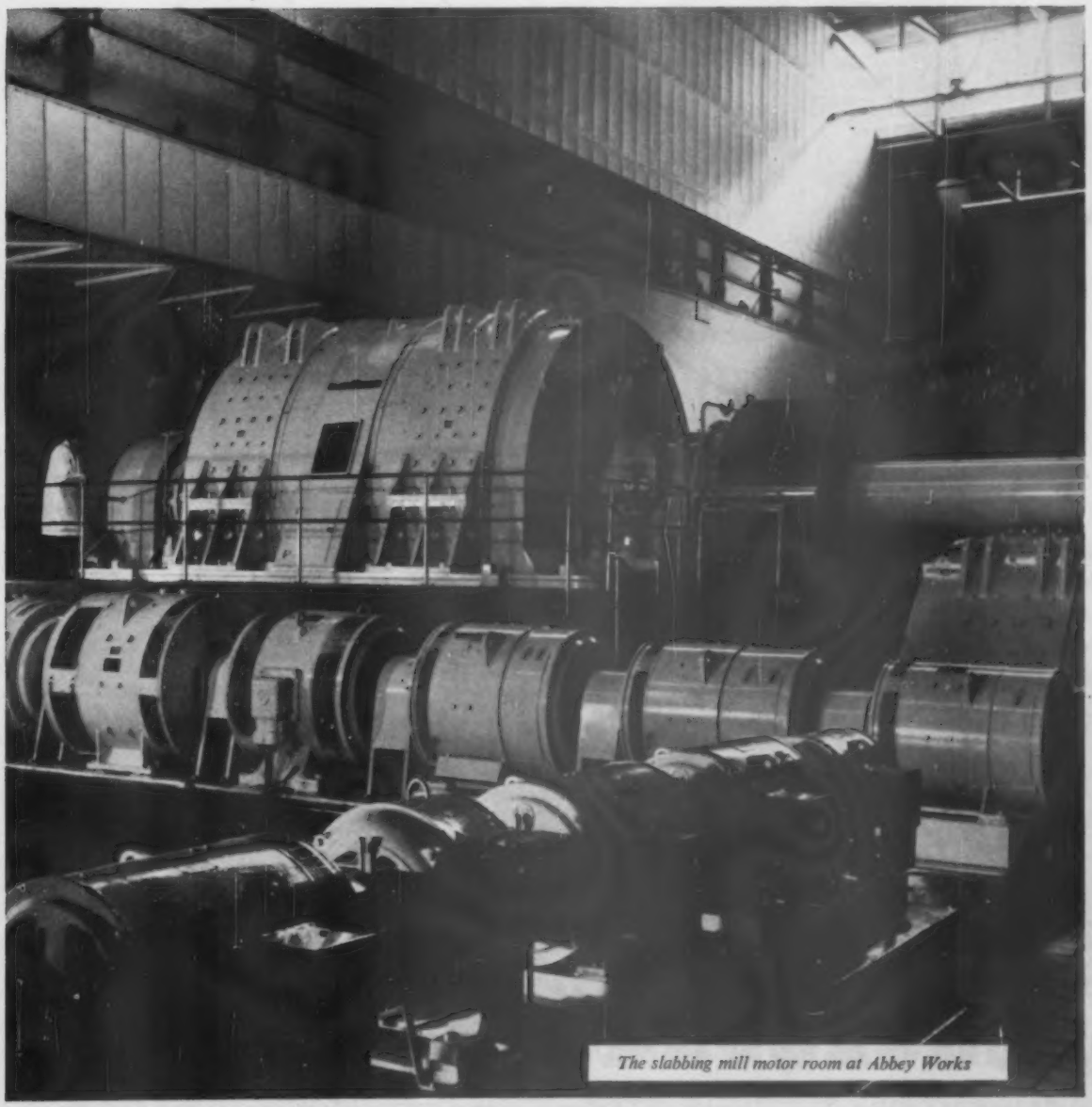
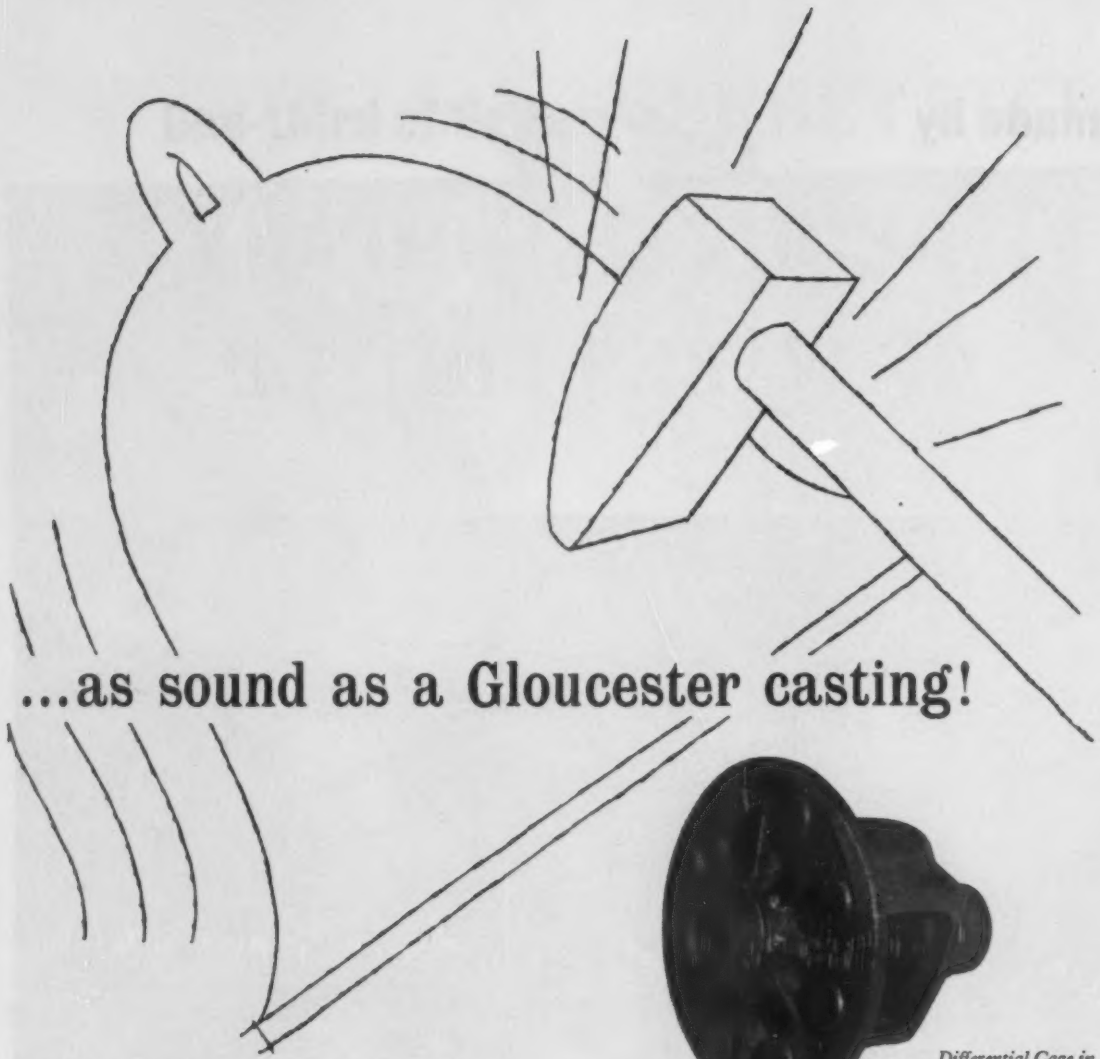
is made by

THE STEEL COMPANY OF WALES LIMITED



The slabbing mill motor room at Abbey Works



...as sound as a Gloucester casting!

Differential Cage in Malleable Iron. Weight 8¼ lbs.

"As sound as a Gloucester Malleable casting" is no mere phrase. It is the result of a wealth of traditional skill and technical knowledge at every stage of production. Raw materials, melting and pouring processes, sand practice, moulding and core making, fettling and setting, all are exactly controlled to ensure castings that will measure up to to-day's exact engineering needs.

They are also accurately set under modern presses, using dies made to the limits required, to ensure that castings can be machined without costly delays.

Always consult Gloucester at the designing stage — even before.

Vehicle Steering Box in Malleable Iron. Weight 6¾ lbs.

A typical Gloucester Malleable specification.

Gloucester Blackheart Malleable	*Gloucester Lamellar Pearlitic Malleable*
Elongation .. 18%	Elongation .. 5%
Yield Point .. 12 tons	Yield Point .. 24 tons
Tensile Strength 25 tons psi	Tensile Strength 35 tons psi

GLOUCESTER

Gloucester Foundry Ltd., Emlyn Works, Gloucester · Telephone: Gloucester 23041 · Telegrams: 'Pulleys' Gloucester
(A subsidiary of the Gloucester Railway Carriage & Wagon Co. Ltd.)

B.M.C *with*

EATON

2-SPEED AXLES

Eaton, 16500 type, two-speed axles are fitted to the B.M.C. Austin '701' and Morris '701' as standard equipment, and contribute to the very low running costs of these popular vehicles.

The combination of high and low ratios in the same axle means twice as many gears are available — the driver having eight forward and two reverse speeds at his command. Electrical control ensures that the correct gear for any condition of service is provided instantly.

Thus labouring uphill in too high a gear or over-revving in too low a gear can be eliminated and fast schedules maintained without harm to engine or transmission. Low engine speed in top gear is however possible with a light load.

MAINTENANCE COSTS AT A MINIMUM

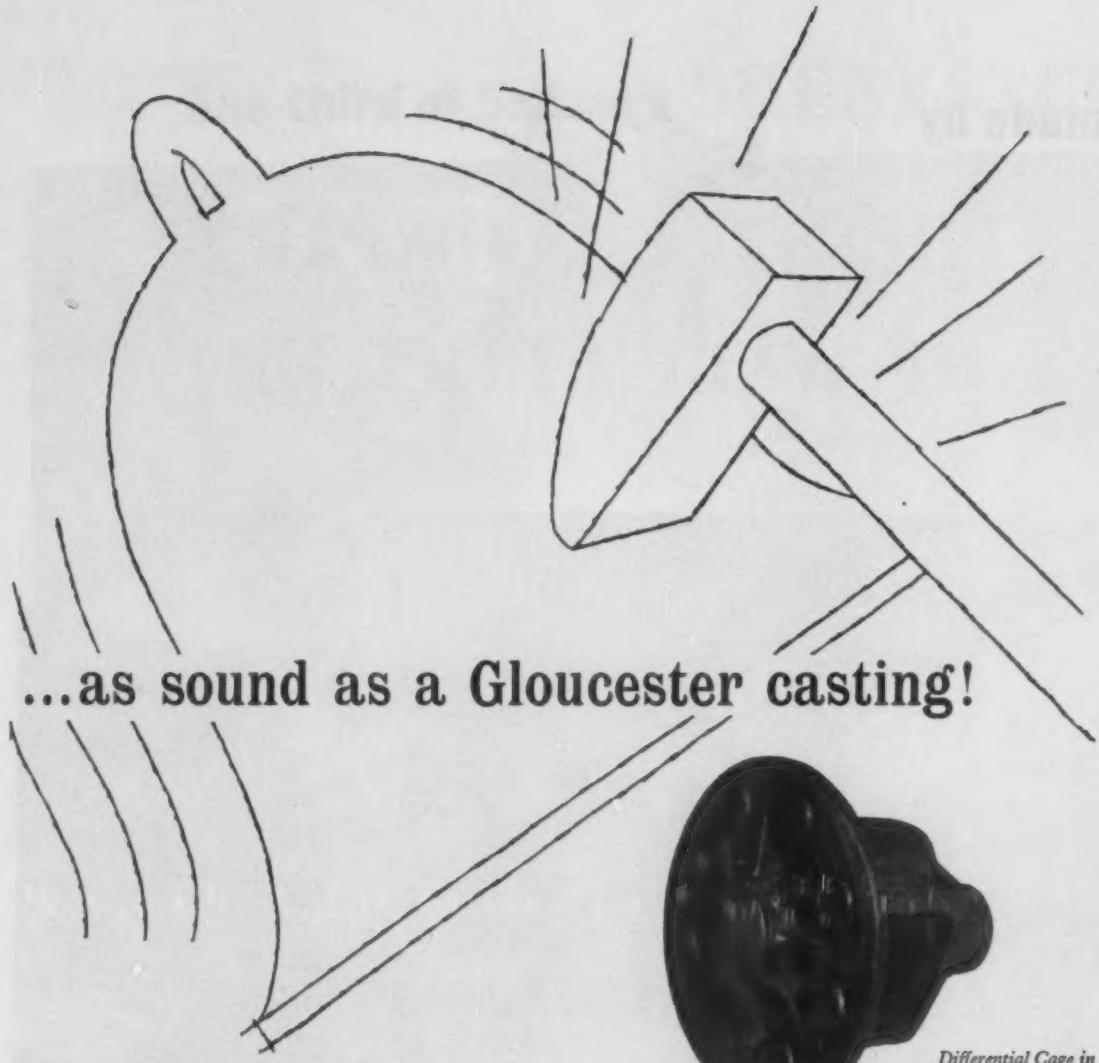
Properly used, the Eaton two-speed axle considerably reduces fuel consumption and wear and tear on engine and transmission, thus giving longer trouble-free service and bringing maintenance costs down to a minimum.

EATON AXLES LIMITED

VICTORIA ROAD, WARRINGTON, ENGLAND

In association with
EATON MANUFACTURING COMPANY, CLEVELAND, OHIO, U.S.A. E.N.V. ENGINEERING CO. LTD. LONDON N.W. 10 · RUBERY OWEN & CO. LTD. DARLASTON

EA 82



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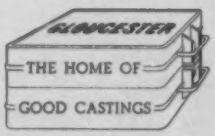
GLOUCESTER



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B.M.C *with*

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EATON AXLES LIMITED

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EA 82

all lined up and

with CAPASCO Regd.

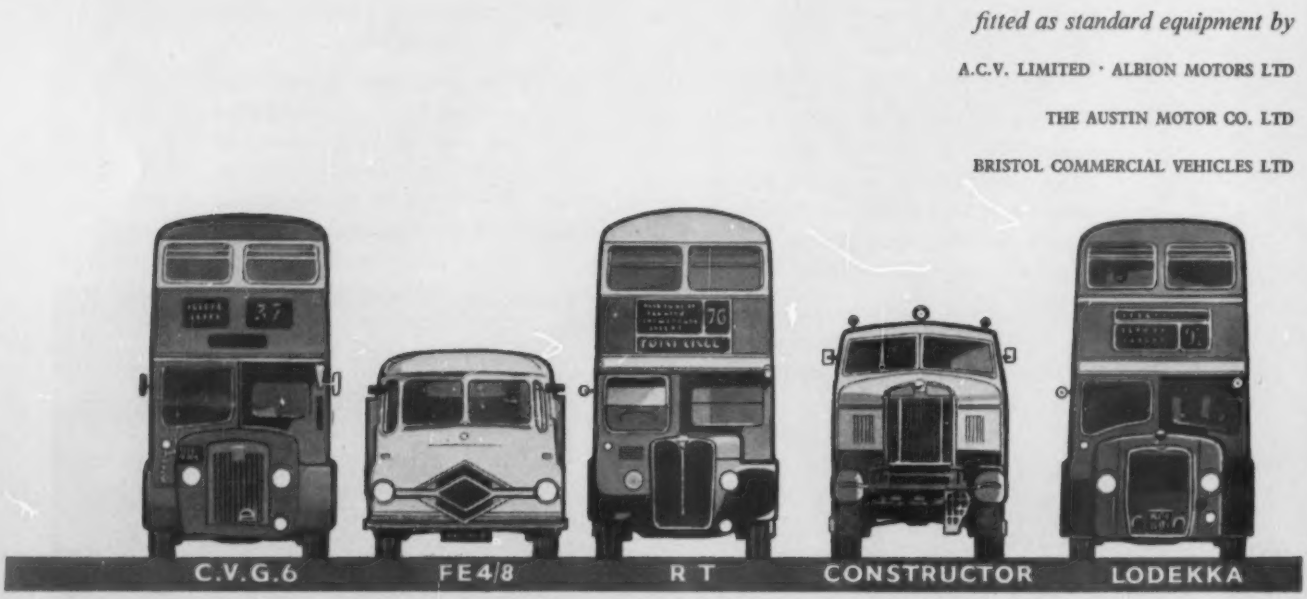
moulded brake

fitted as standard equipment by

A.C.V. LIMITED · ALBION MOTORS LTD

THE AUSTIN MOTOR CO. LTD

BRISTOL COMMERCIAL VEHICLES LTD



THE CAPE ASBESTOS COMPANY LIMITED

and at MANCHESTER: National Buildings, St. Mary's Parsonage, Manchester 3. Tel: Deansgate 6016-7-8; GLASGOW: 217 Bothwell Street, Glasgow C.2, Tel: Central 2175
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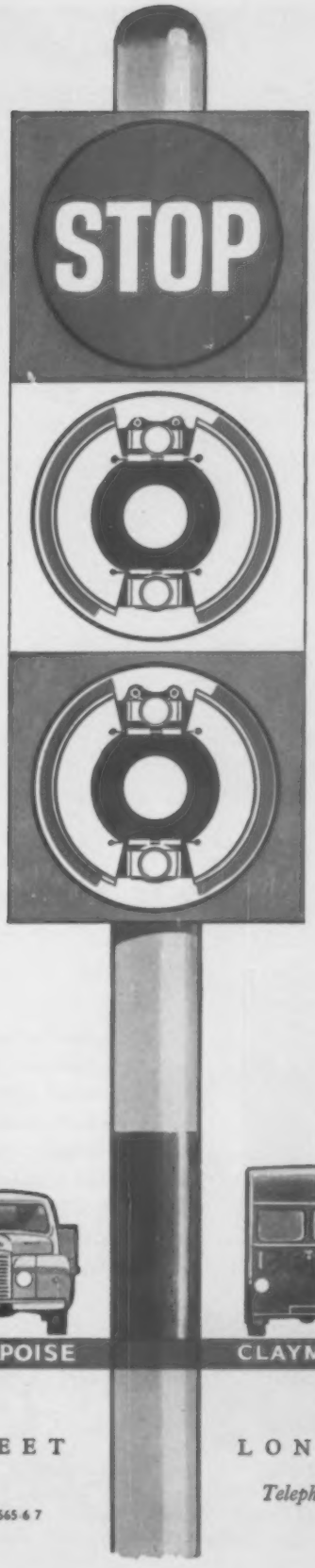

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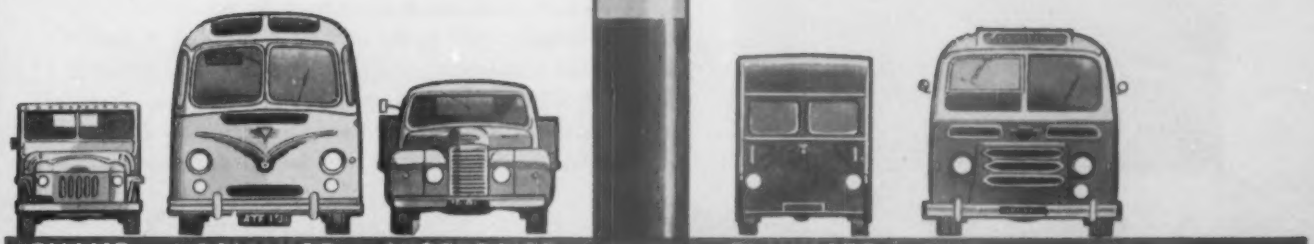

114 & 116 PARK STREET LONDON W.1

Telephone: GROsvenor 6022

BIRMINGHAM: 11 Waterloo Street, Birmingham 2. Tel: Midland 6565 6 7

CAPE

TA 9471

Seat being fitted into 'Bus interior

HAVE YOU A NEED SIMILAR TO THIS?

—it is an idea to capture the imagination of engineers, faced with the difficulty of instant and rigid attachability. The GRIP follows, in good tradition, the ten-year-old BOLLARD of which hundreds of thousands are in constant use.

The "Flexilant" GRIP makes anything to which it is fixed, instantly and automatically attachable, detachable and replaceable. It is rigid and firm—self-placing and hygienic. It is simple, inexpensive and as long-lasting as the part to which it is fitted. Here is an example of its use—have you a similar need?

THE *"Flexilant"* GRIP

PROV. PAT. NO. 16783/55.

can help your fixing problems

RBP4

RUBBER BONDERS LIMITED · DUNSTABLE · BEDFORDSHIRE · ENGLAND

POLLARD 'MAX-LOAD' roller bearings

universally used throughout the world

Photograph by courtesy of Caterpillar Tractor Co. Ltd.

Equivalent and interchangeable with bearings of American type and manufacture.

Our catalogue MAX/54 giving full details of dimensions, cage, lip, circlip, and full of roller types, arrangements, special features, etc., is available on application.

The bearing shown above is a typical example of the numerous designs of "Max-Load" bearings obtainable.

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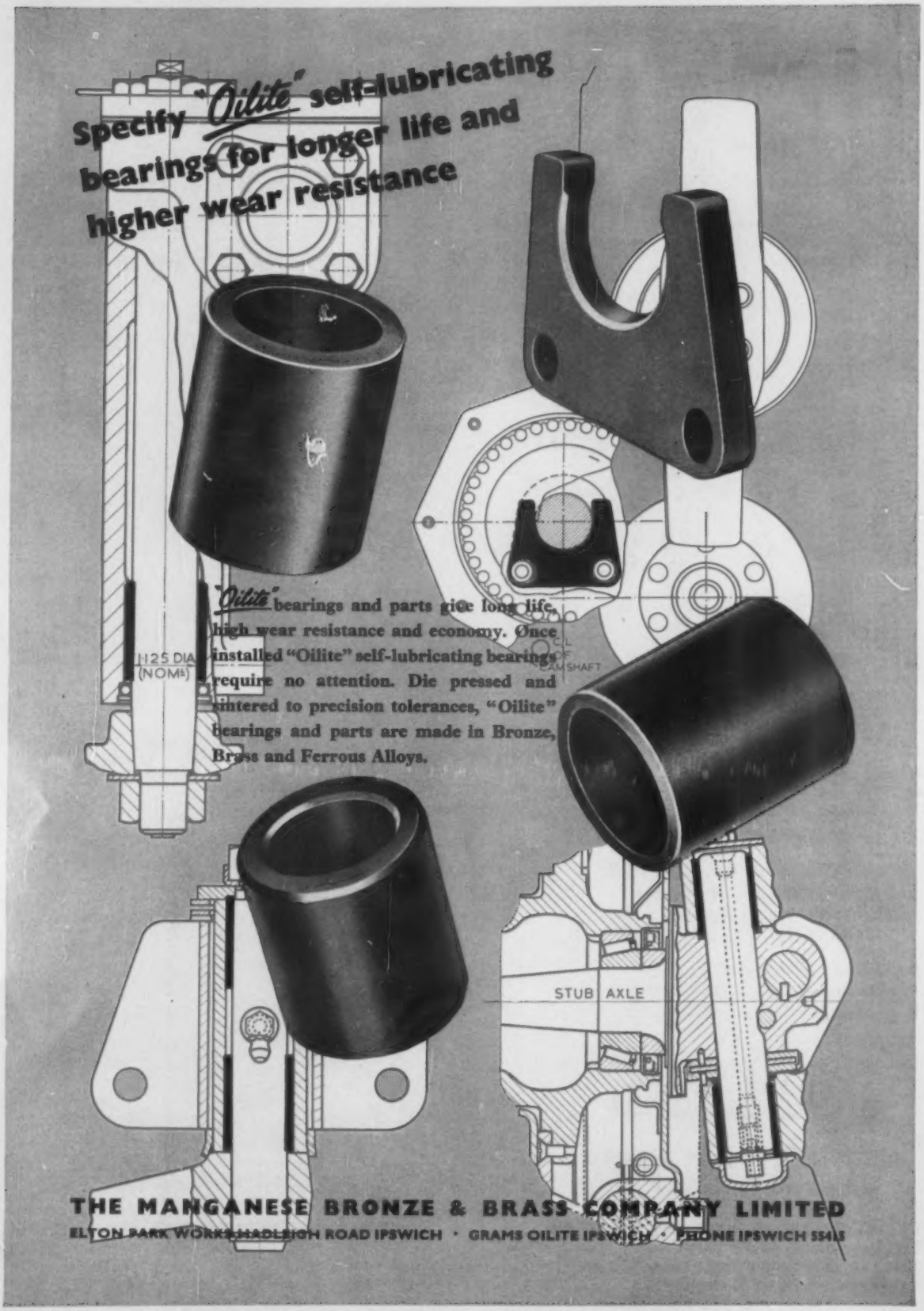
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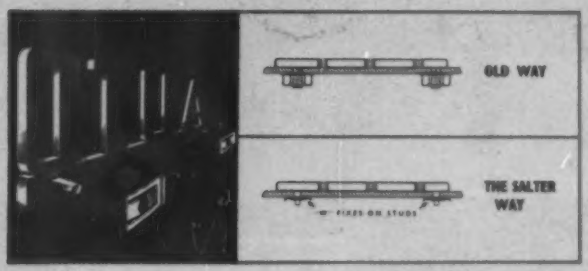

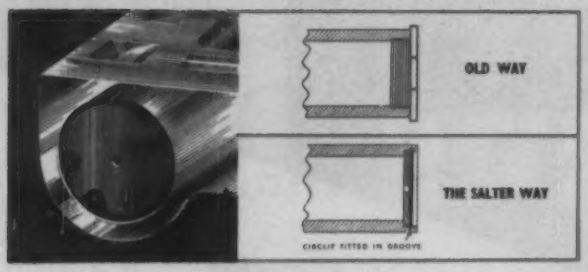

reduce assembly time–

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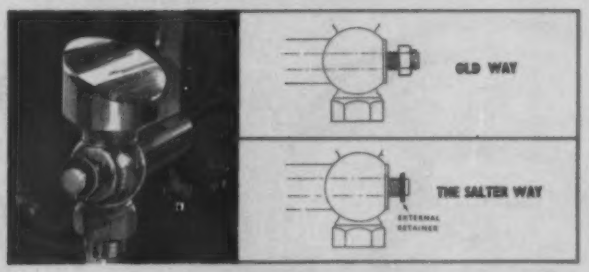

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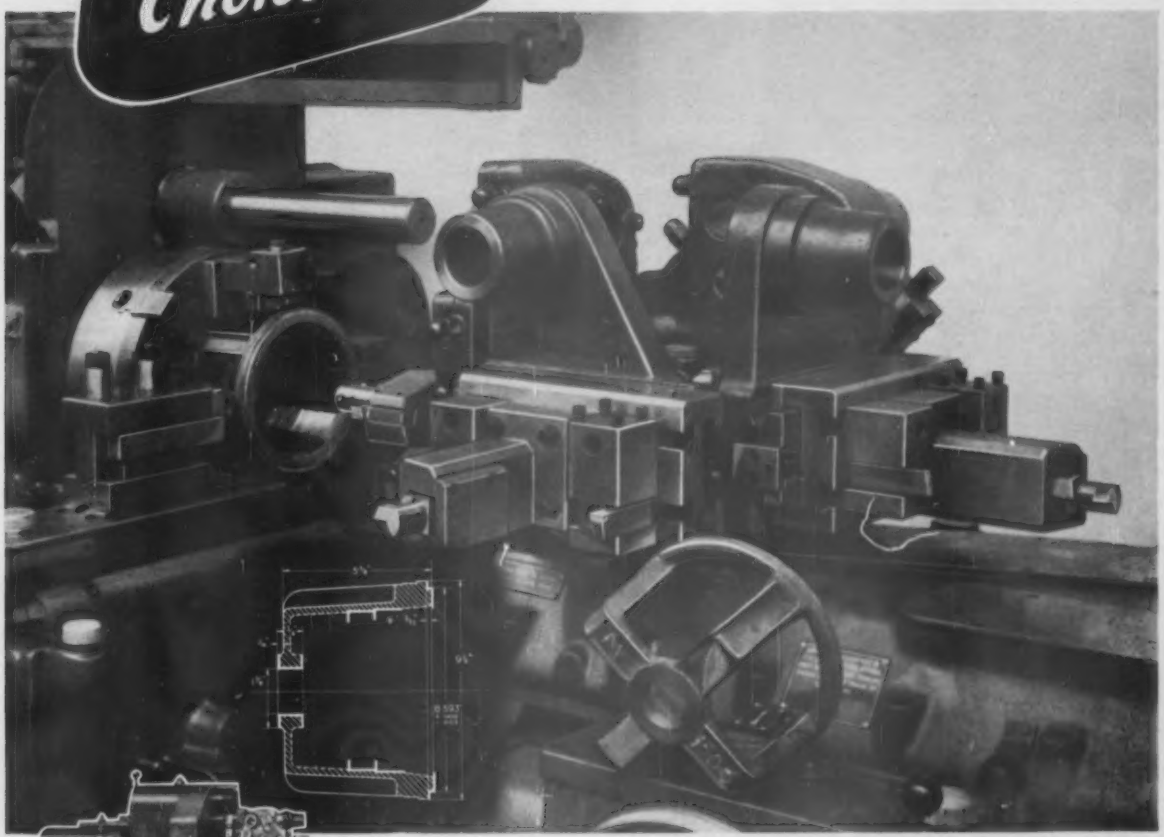

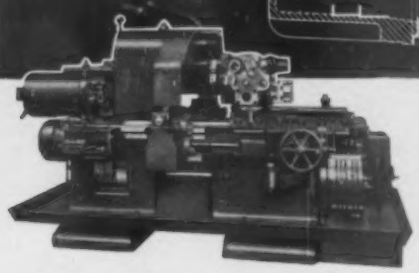

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Greatest output per foot of floor space at lowest labour cost per piece—one operator and one tool setter can keep from four to six machines in continual operation.
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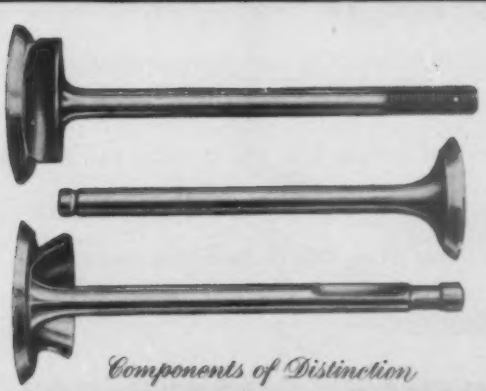

Components of Distinction

Means to an end

The hypodermic syringe is only one of the weapons in a doctor's armoury. But, like many others its efficiency owes much to correct heat-treatment. That's where Wild-Barfield come in. We pioneered the use of the centrifugal fan, and forced air circulation is still the best available means of tempering, secondary hardening, etc. Correct heat-treatment is only a means to an end, but it does require properly designed furnaces. We've been making them for over 40 years.

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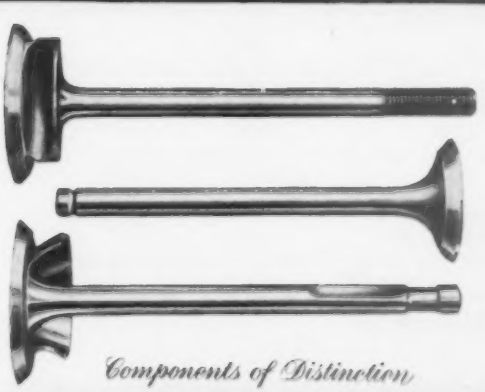
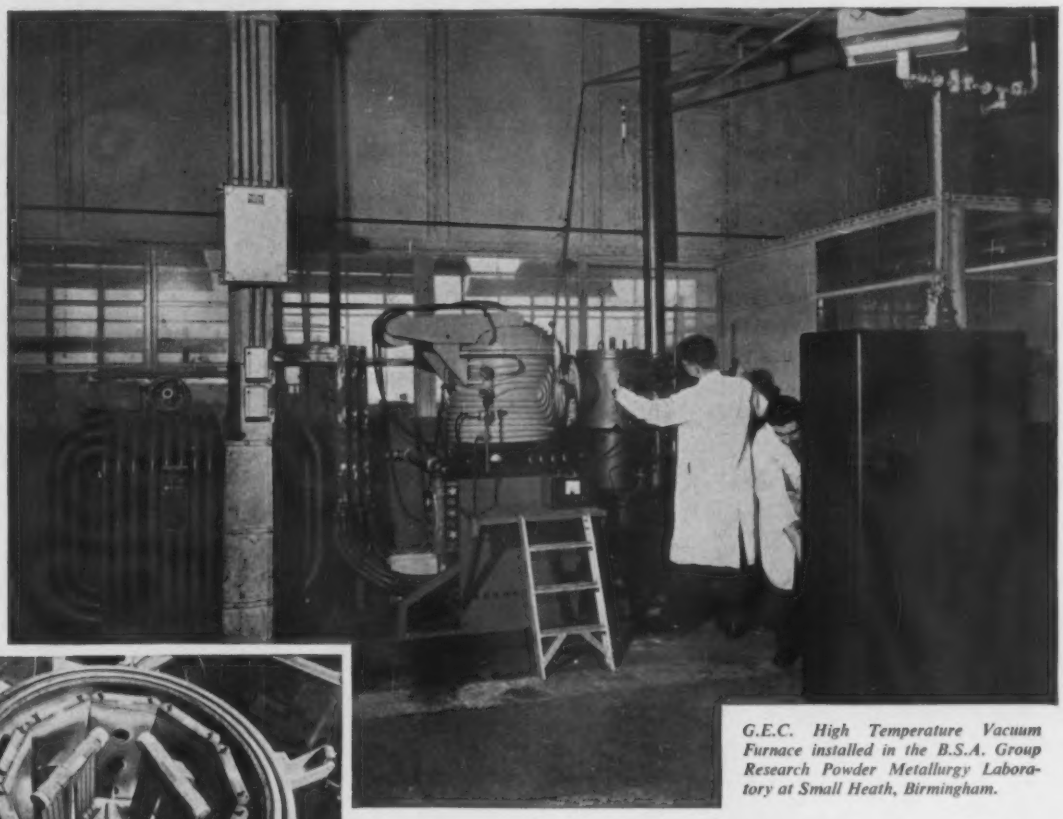
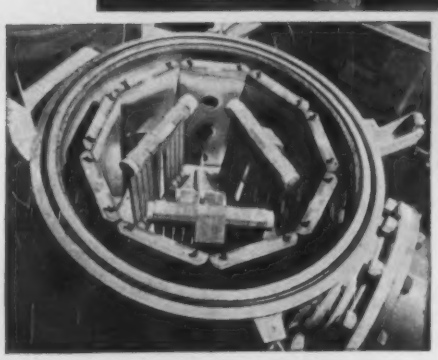


Components of Distinction

B.S.A. use a G.E.C. High Temperature Vacuum Furnace...



G.E.C. High Temperature Vacuum Furnace installed in the B.S.A. Group Research Powder Metallurgy Laboratory at Small Heath, Birmingham.



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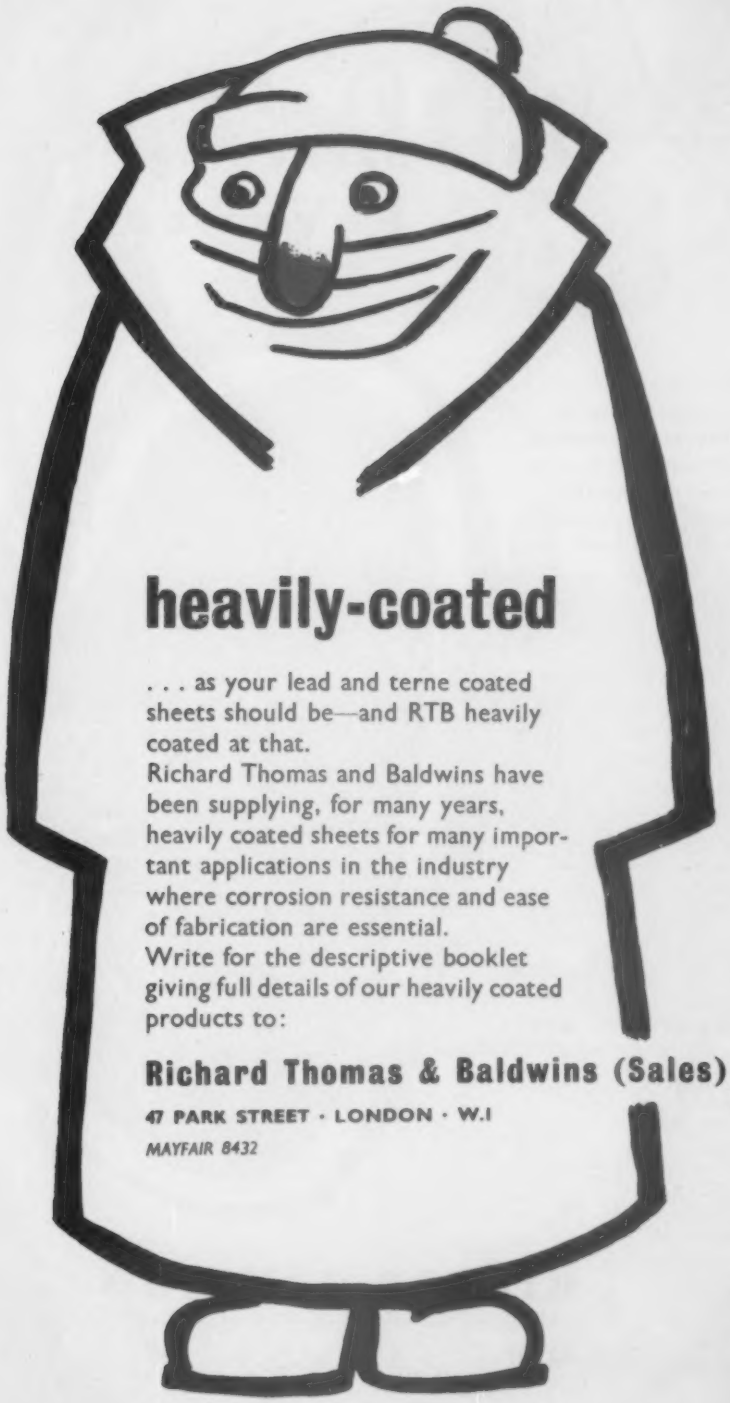

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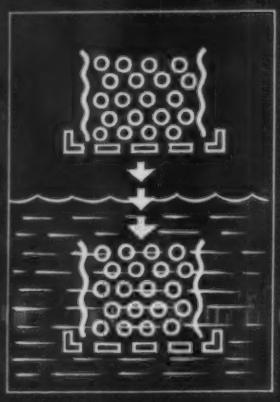

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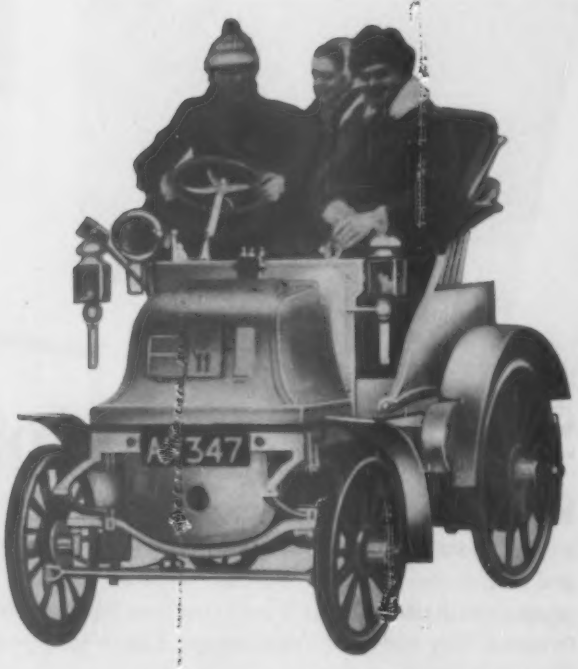

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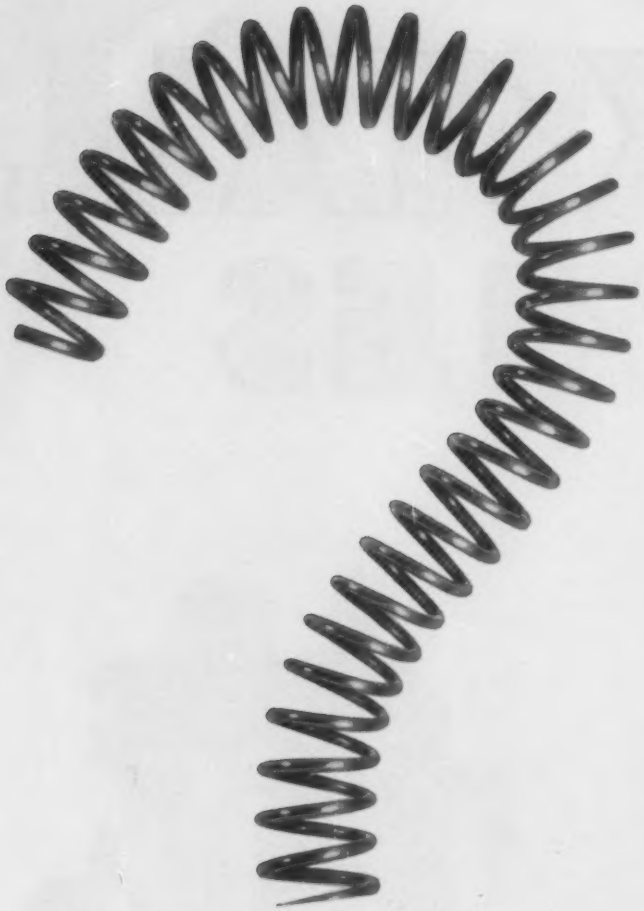

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If so, Terry's BOXES OF ASSORTED SPRINGS are the answer. Here you have a marvellous assortment of Compression and Expansion springs . . . in all varieties, weights, lengths, gauges and diameters. The 9 boxes we show here are only a few from our very wide and varied range. Let us send you a fully illustrated list—post free.

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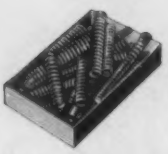
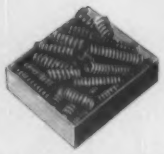
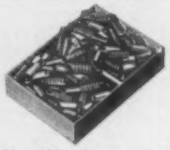


No. 760. 3 doz. Assorted Light Compression Springs 1″ to 4″ long, 22 to 18 S.W.G., ¼″ to ½″ diam. 6/6 each.

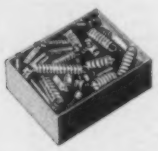


No. 98A. 3 doz. Assorted 1″ to 4″ long, ½″ to ¾″ diam., 19G to 15G. 5/6 each.

No. 757. Extra Light Compression, 1 gross Assorted, ½″ to ¾″, ¼″ to 2″ long, 27 to 20 S.W.G. 15/- each.

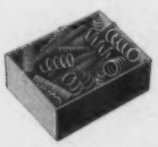


No. 388. ½ gross Assorted Small Expansion Springs. ¾″ to 1½″, 18G to 21G. 9/6 each.

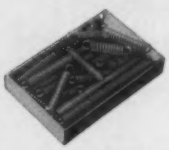


No. 758. Fine Expansion Springs. 1 gross Assorted ¼″ to ¾″, ½″ to 2″ long, 27 to 20 S.W.G. 15/- each.

No. 466. ½ gross Assorted Small Expansion Springs ¾″ to 1¼″ long, 3/32″ to 3/16″ diam., 21G to 24G. 6/6 each.



No. 1013. 1 gross Small Coil Compression Springs, ¾″ to 1½″ long, 3/32″ to 7/16″ diam., 24G to 19G. 6/- each.



No. 753. 3 doz. Assorted Light Expansion ¼″ to ½″ diam., 2″ to 6″ long, 22 to 18 S.W.G. 10/6 each.

Cut Production costs with TERRY Wire Circlips *(Square Section)*

We can supply from stock in sizes from ⅛″ to ¾″.

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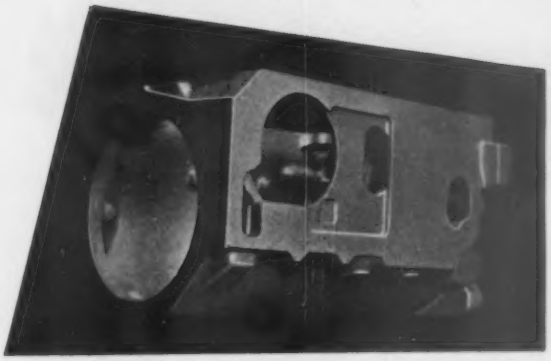
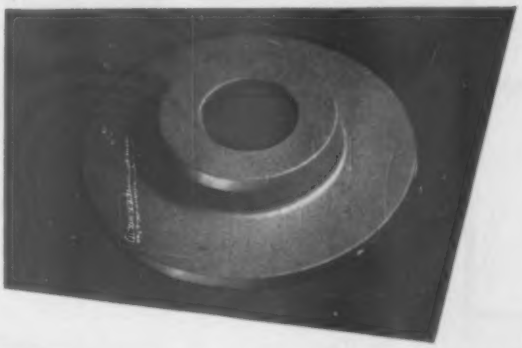


AUTOMATIC GEARBOX CASE *(COURTESY OF ROLLS-ROYCE LTD)*



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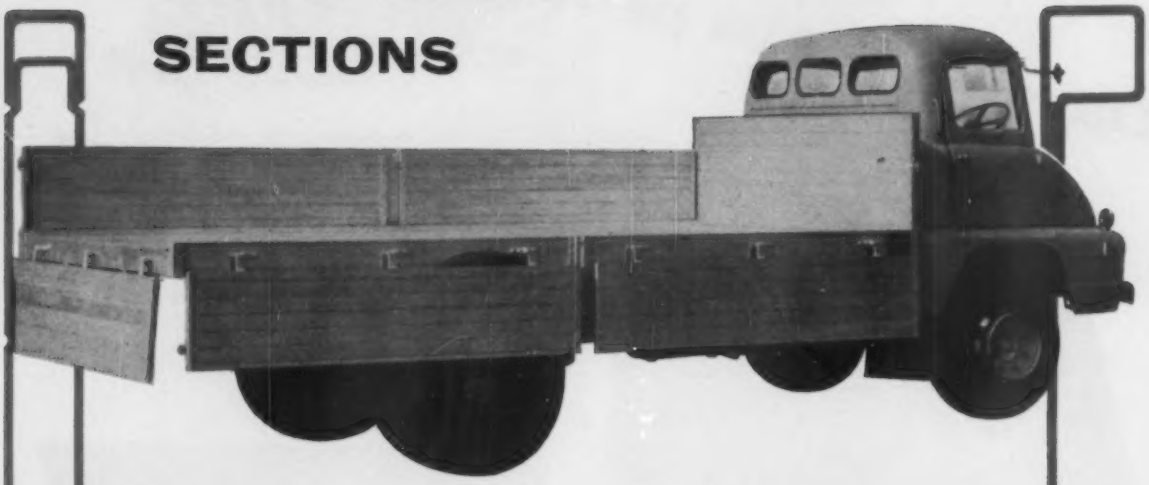

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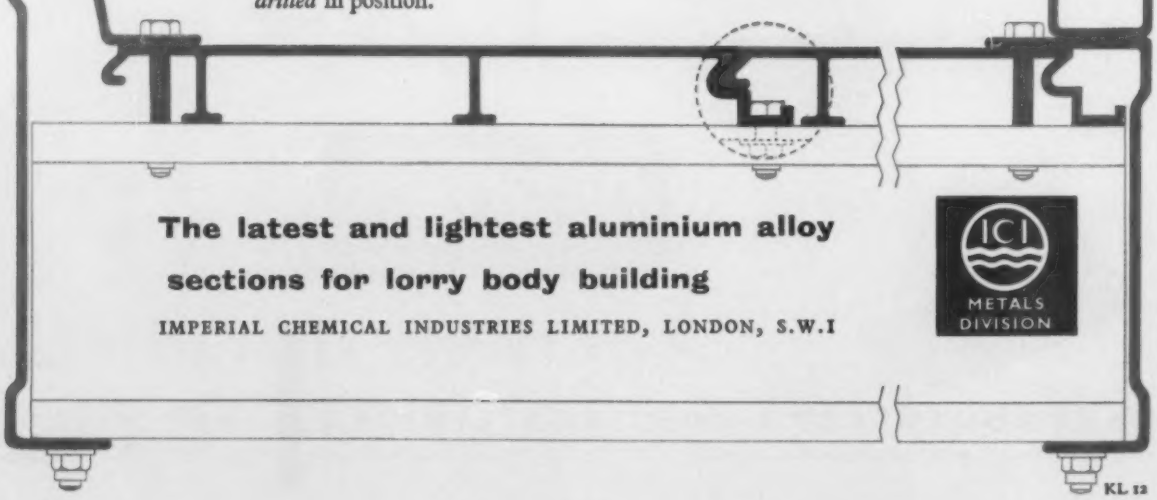
- ★ Greatly improved weight/load ratio.

★ *Floor sections and cross-bearers can be drilled* in position.

★ *Floor fixing bolts readily accessible.*



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for internal and external superfinishing
This illustration shows external superfinishing on Gudgeon Pins in the Patricroft works of L. Gardner & Sons Limited, the well-known oil engine builders. Two further machines are employed in the same factory for high precision bore finishing on cylinder blocks.
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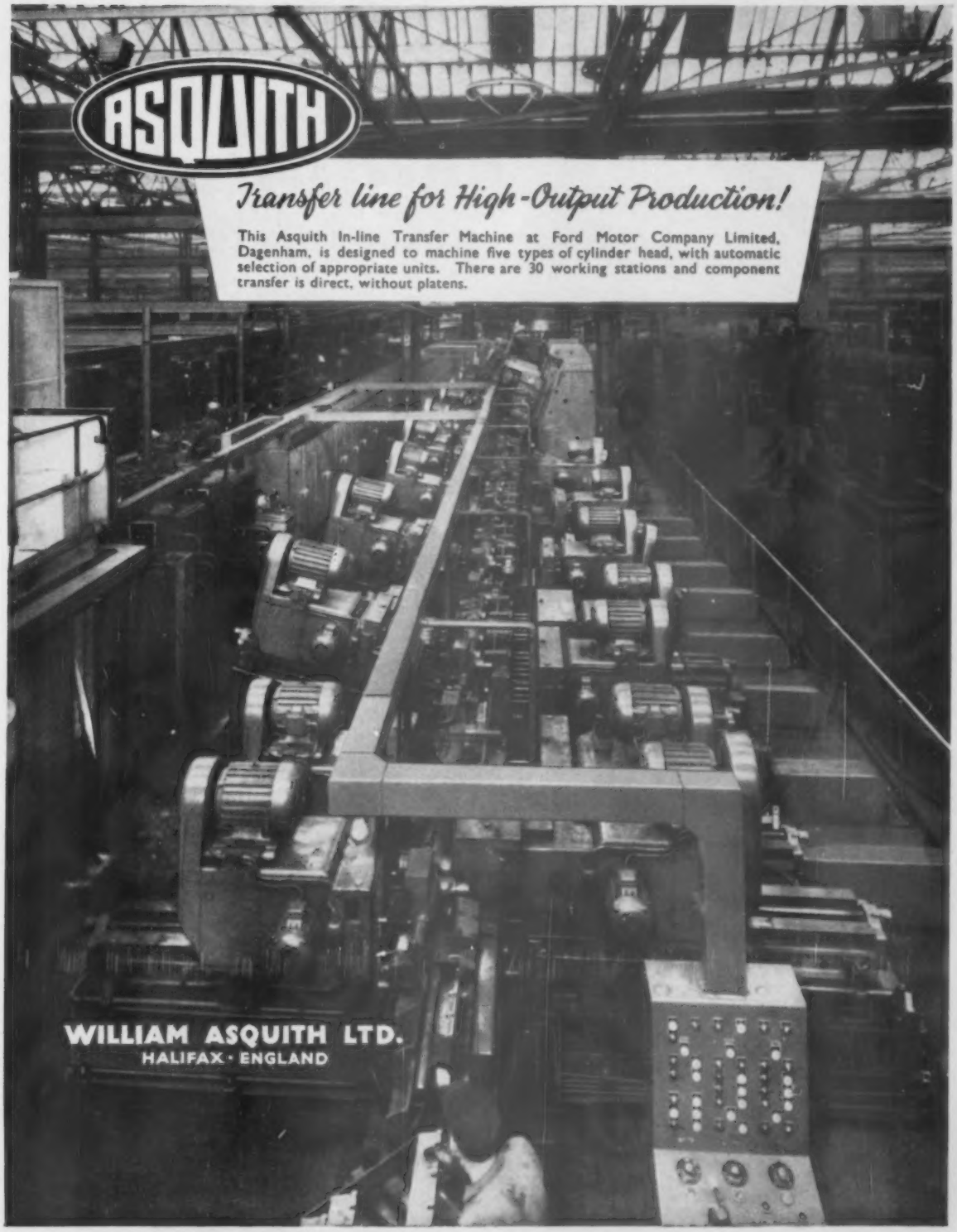
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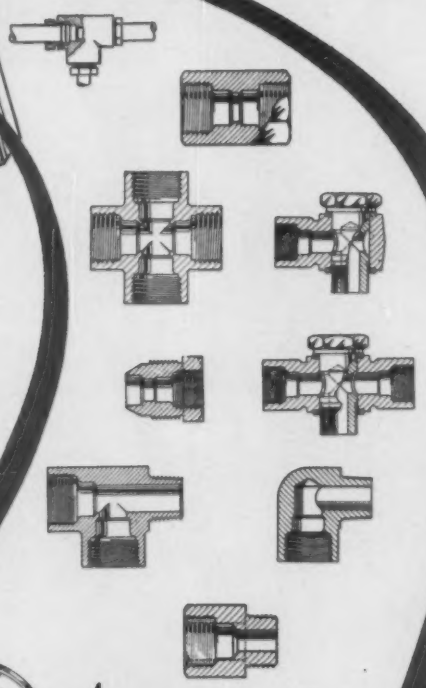
A257

Fitted any good unions lately?



More and more manufacturers are standardizing on Enots brass solderless unions because :

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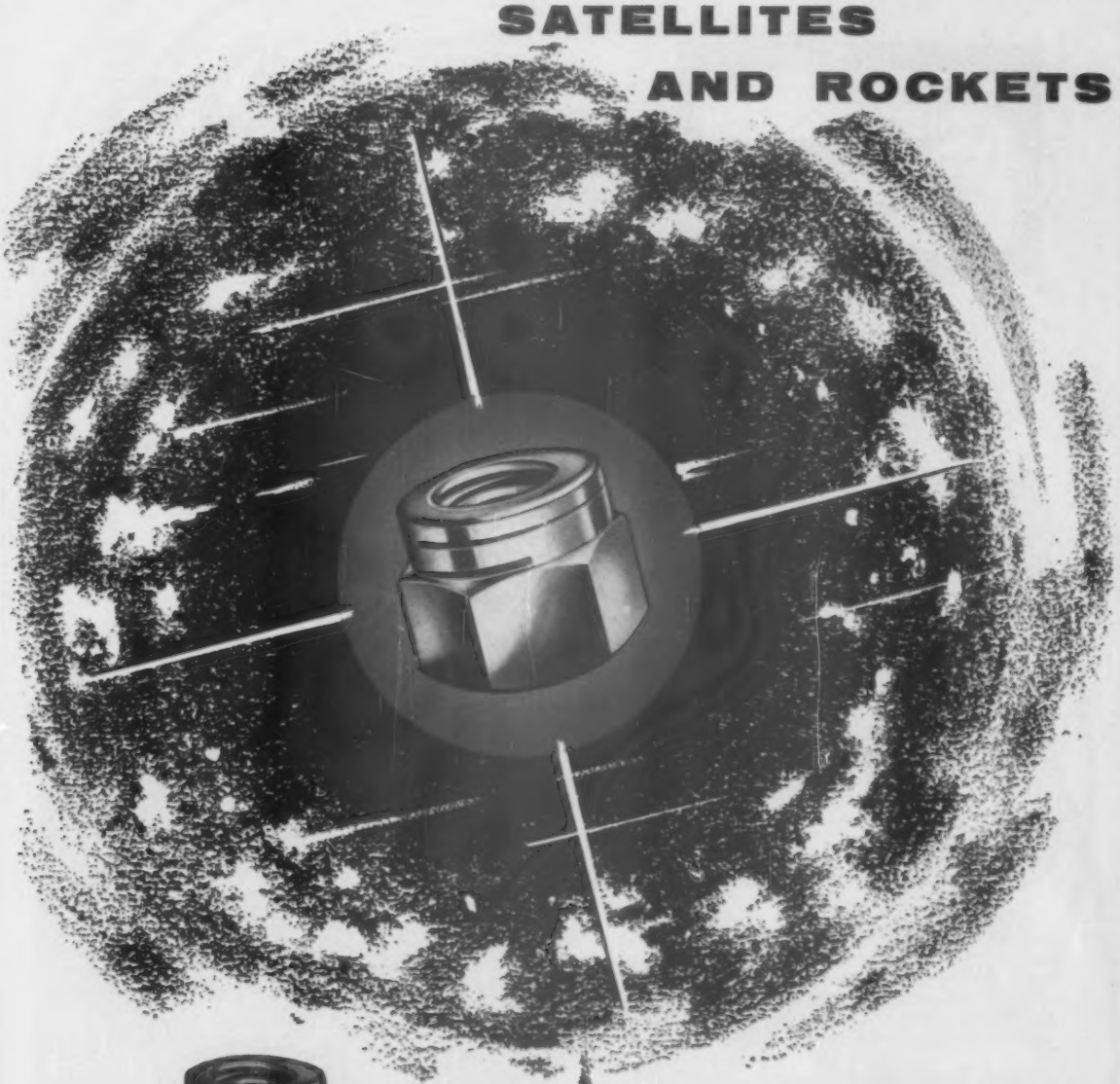

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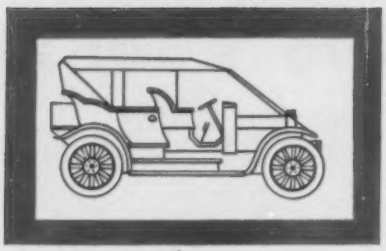

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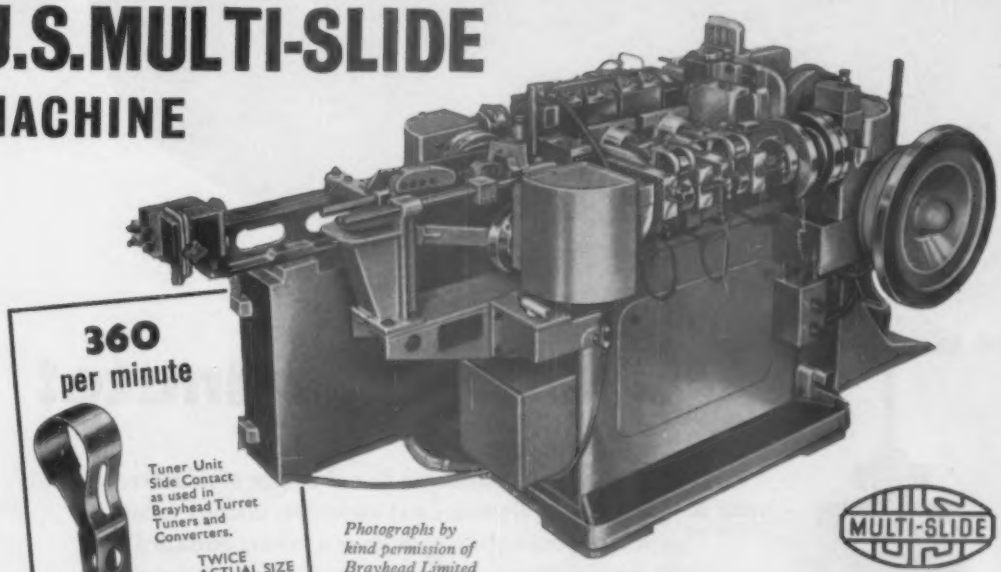

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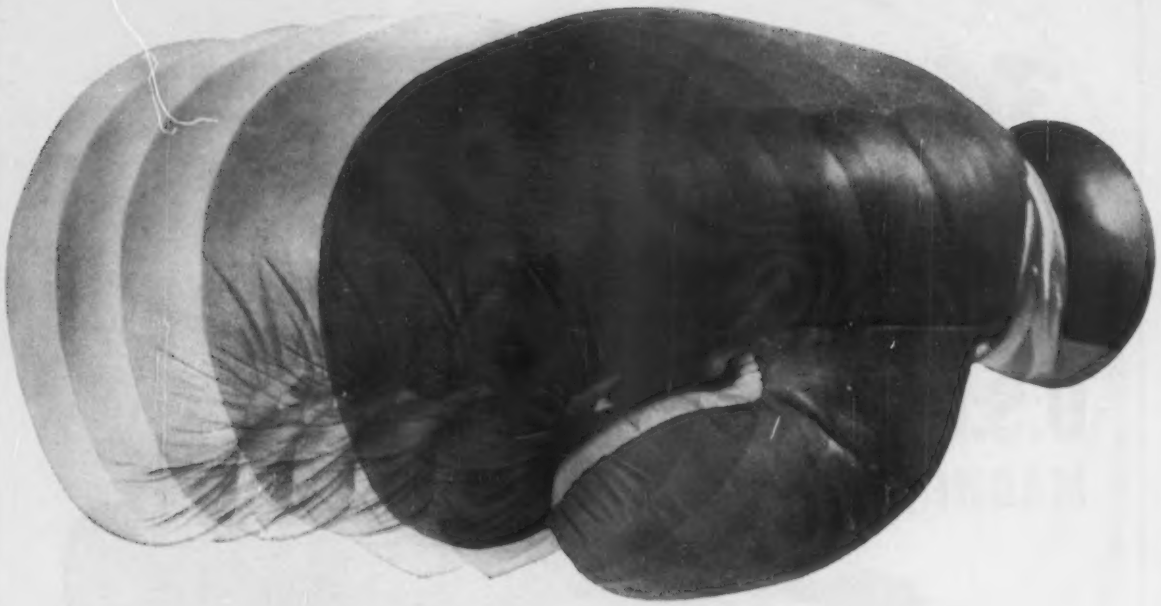

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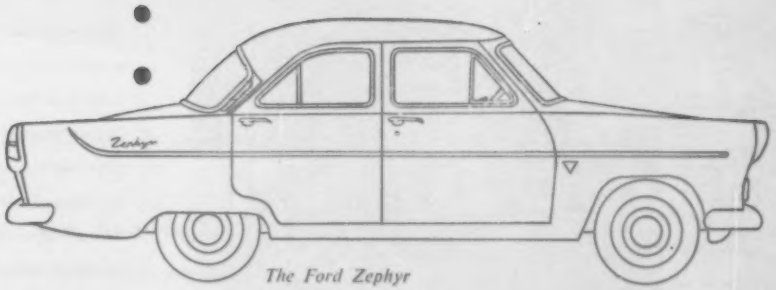

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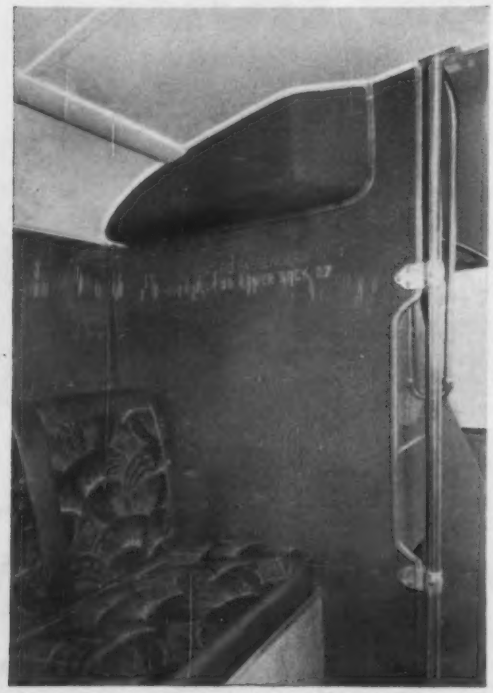

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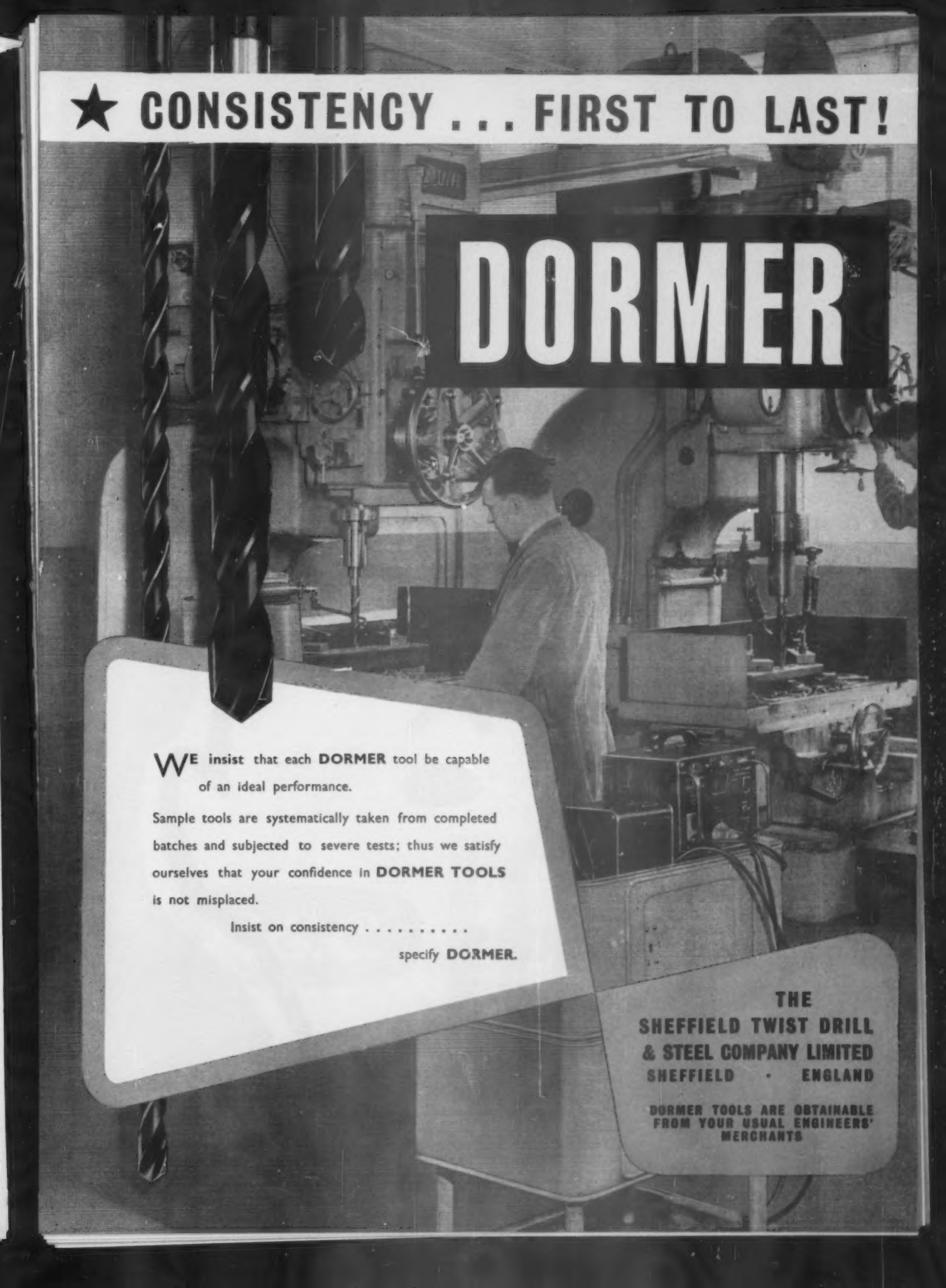
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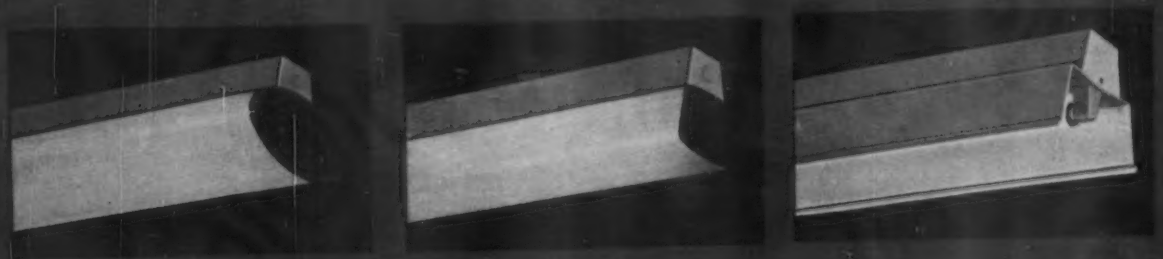

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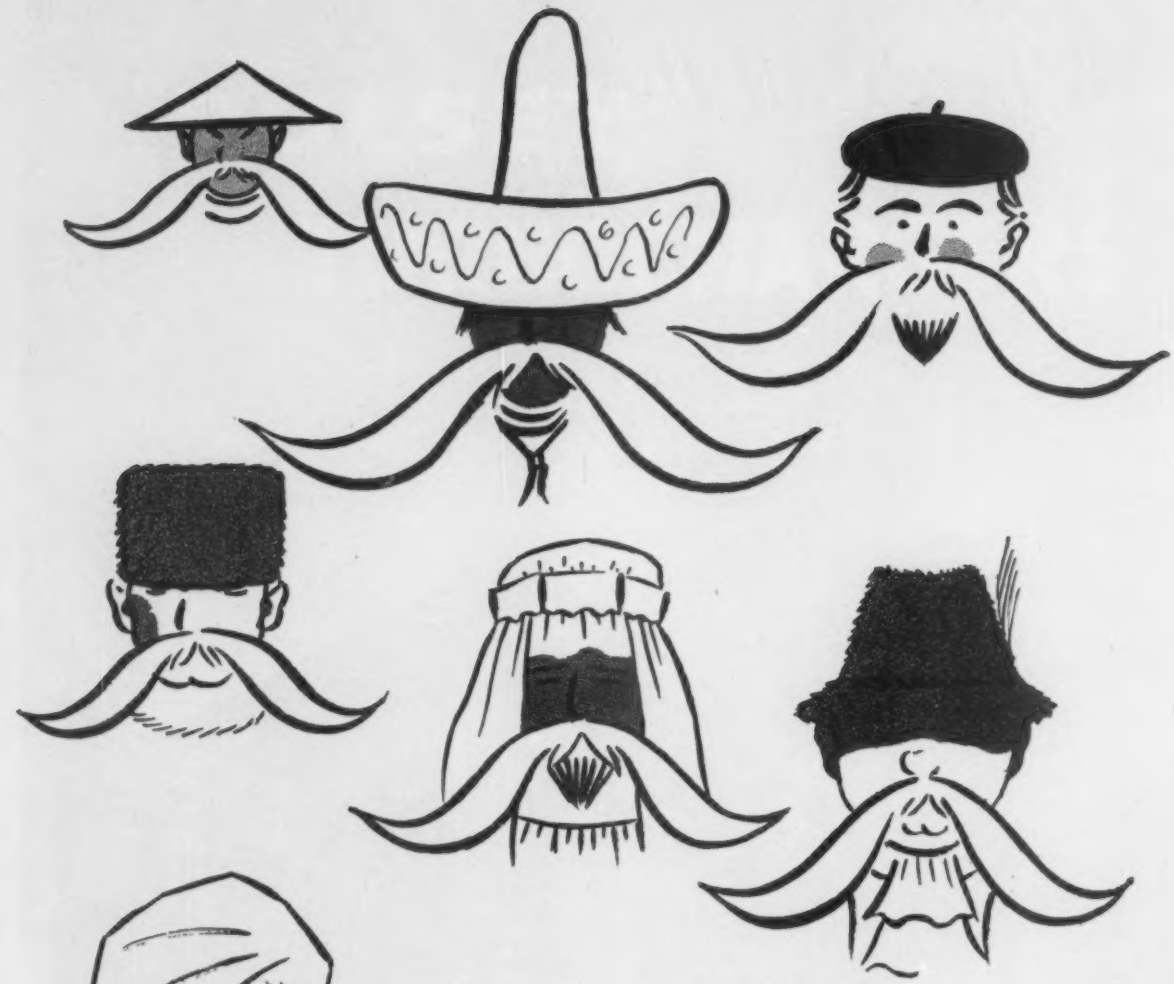

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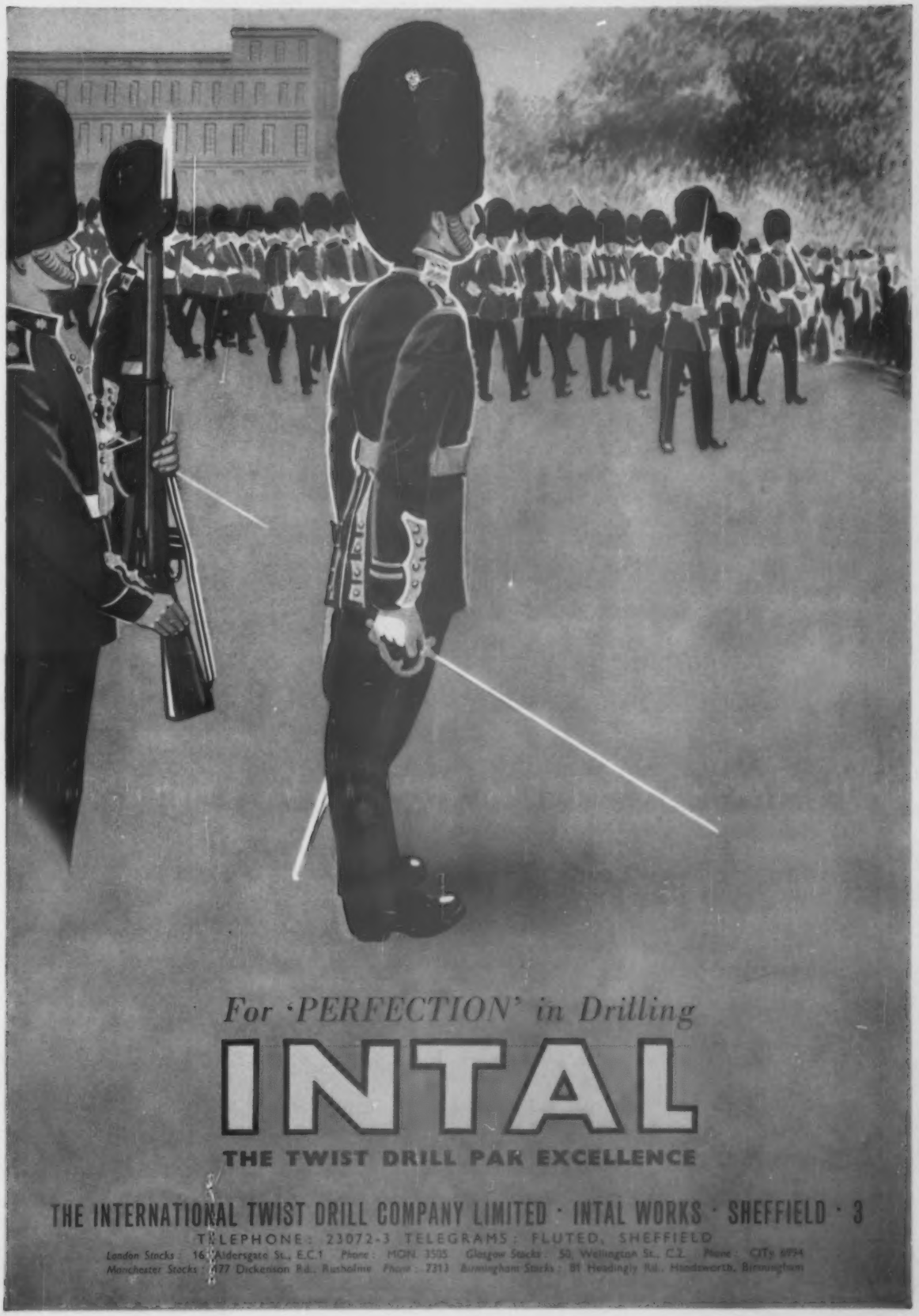
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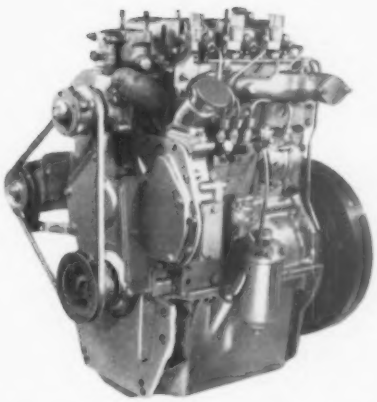

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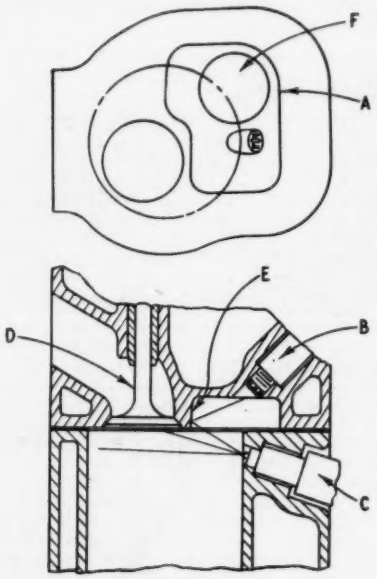
VOLUME 48 **NUMBER 2** **FEBRUARY 1958**

Fuel-injection, mixture-compressing engine

This arrangement of a petrol-injection engine has a relatively shallow combustion space A formed in the cylinder head and extending laterally beyond the circumference of the cylinder bore. The spark plug B is located at an angle in the roof of the combustion space and the injector C



No. 768520

at an angle in the cylinder wall; both lie in a plane containing the cylinder axis. Of the type delivering a conical fuel spray, the injector is directed towards the inlet valve D seated vertically in the face of the cylinder head. The uppermost portion of the fuel spray, however, enters the combustion space and is reflected from the surface of the wall E, which is at an angle to the vertical, towards the spark plug electrodes. Exhaust valve F is mounted vertically in the combustion space.

Advantages claimed for the arrangement are that the main portion of the fuel is directed towards the air entering past the inlet valve; a portion of the spray is reflected towards the spark plug zone and ensures ignition under all conditions of operation; and the hot exhaust valve is adjacent the spark plug and minimizes any tendency to pinking. *Patent No.* 768520. *Daimler-Benz A.G.* (*Germany*).

Power-assisted steering gear

On this rack and pinion steering gear the hydraulic servo-motor intervenes only at moderate and low speeds when manual operation of the steering wheel becomes difficult. The gear comprises a casing A in one end of which is a cylinder B in which slides a piston mounted on a rod connected to the rack C. Engaging the rack is a pinion D secured on a sleeve E coupled by a rubber bushing F to the tubular steering shaft. Both sleeve E and the steering shaft are formed with diametrically opposite slots, the one longitudinally and the other at an angle of, say, 45 deg. These slots are engaged by four rollers on the head of a T-shaped member G carrying the slide of the hydraulic control valve H.

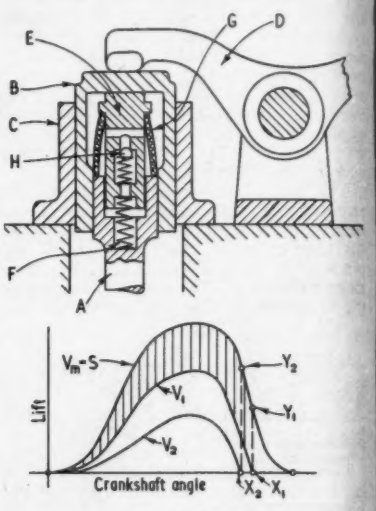
On one side of this valve is a branched return line to reservoir J and a centrally disposed pressure line from the pump K and the accumulator L. From the other side, two lines are connected respectively with opposite ends of the power cylinder B. These lines are cut by a two-position slide valve M which either places the lines in communication with the cylinder ends or shuts off the lines and places the two ends of the cylinder in communication with each other. Operation of this valve may be manual or automatic to bring in the hydraulic system at vehicle speeds less than 25 km/hr or when first or reverse gears are engaged.

The rubber coupling F is so rigid that under normal running conditions the relationship between sleeve E and the steering shaft is unaffected. When, however, the rack is opposed to a resistance greater than the predetermined value, the coupling flexes angularly and the juxtaposed slots move the member G and the control valve slide to connect the pressure line to the appropriate end of the actuating cylinder. The piston then operates the steering gear through the rack. *Patent No.* 768264. *S. A. Andre Citroën* (*France*).

Automatic regulation of valve lift

The lift of an engine valve is automatically regulated in dependence on engine speed by means of a hydraulic device incorporated in the valve operating mechanism. Decreasing engine speed gives a smaller, and increasing engine speed a larger, valve lift. The velocity of the stream of air or mixture entering the cylinder at low engine speeds is substantially increased as a result of the throttling action, while full charging is ensured at high engine speeds. On engines arranged with overlapped timing the system shows to advantage as the smaller valve lift at low engine speeds reduces the overlap and consequently the loss of unburnt mixture. Starting and tick-over are also improved, it is claimed.

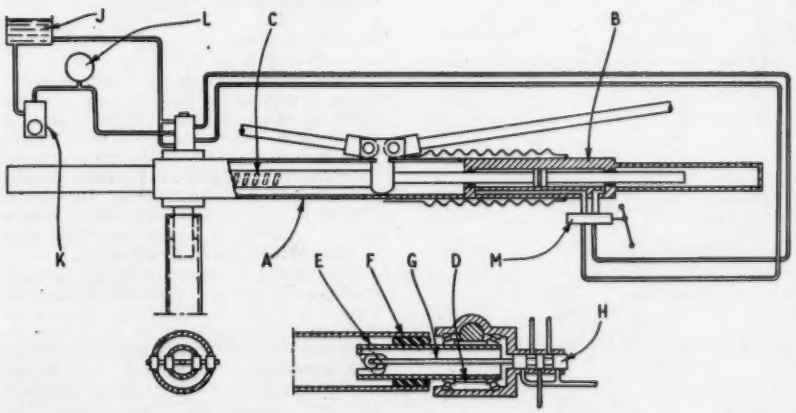
In the example, a pushrod A actuates,



No. 768336

through a plunger B guided in a bushing C, a conventional overhead rocker lever D. A piston-type regulating member E is guided in the end of the pushrod and, under the constraint of spring F, holds plunger B up to the rocker end. The head of member E is sealed to the top of the pushrod by means of a resilient bellows G to form a reservoir for hydraulic fluid. A spring-loaded, non-return valve H is arranged in the interior of member E to control the passage connecting the pressure space, below member E, and the reservoir. When the device is subjected to axial pressure, either by the pushrod when the engine valve is being opened or by the rocker when the valve is being returned to its seat, the non-return valve closes and fluid can be transferred from pressure space to reservoir only by way of the clearance between member E and the pushrod guide at a predetermined leak rate. Between strokes the clearance between plunger B and rocker lever D is taken up by spring F; valve H opening and fluid being returned from the reservoir to the pressure space.

The diagram shows pushrod stroke and valve lifts plotted against crankshaft angularity. At high speed the device is substantially rigid and the valve lift V_m is equal to the pushrod stroke S. However, as speed is decreased the valve lift is reduced as shown by curves V_1 and V_2 and the closure of the valve occurs earlier, as at X_1 and X_2. In these circumstances clearance arises in the operating mechanism from points Y_1 and Y_2 on the pushrod curve S. Also described is an application of the device to the pivot bearing of a tappet finger operating in conjunction with an overhead camshaft. In that instance the device does not add to the reciprocating weight of the mechanism. *Patent No.* 768336. *Daimler-Benz A.G.* (*Germany*).



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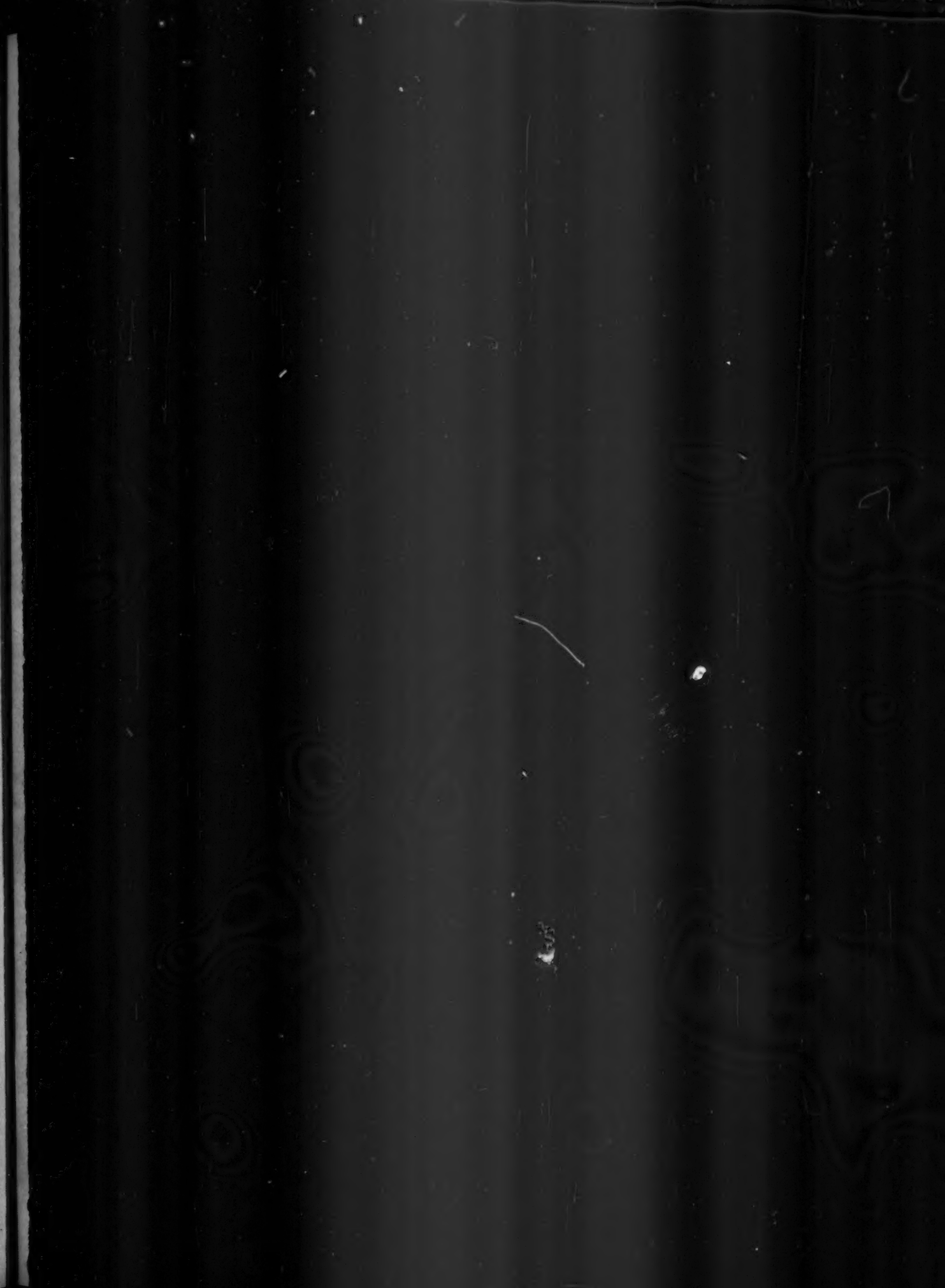

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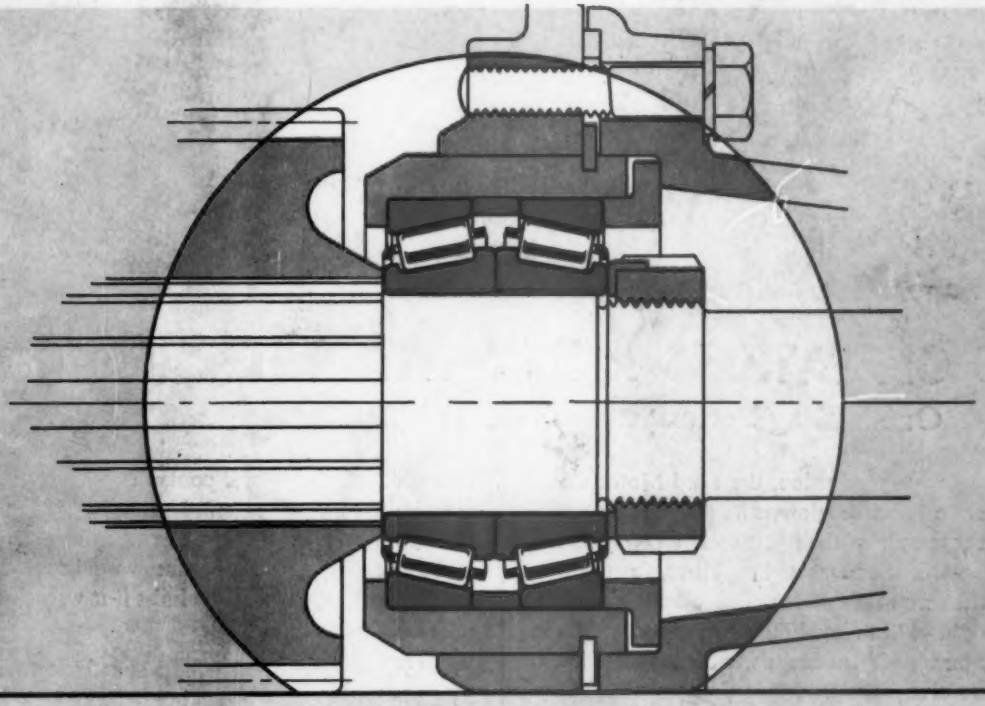

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The drawing shows a pair of Timken bearings in this situation, with their pre-load controlled by a spacer supplied with the bearings, giving an arrangement which is proof against mal-adjustment.

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Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment

AUTOMOBILE ENGINEER

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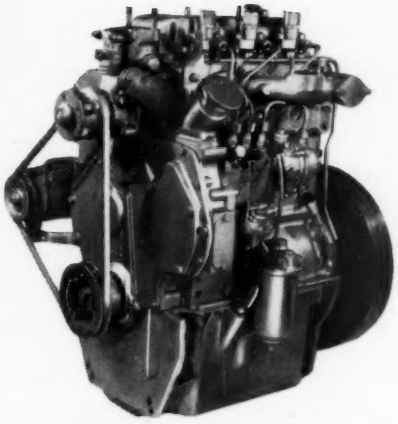

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VOLUME 48 **NUMBER 2** **FEBRUARY 1958**

The Conquest of Friction

In a bas-relief found at Nineveh there is shown the transport on skids of a huge sculptured stone; a horde of slaves pull on ropes while others assist with a large lever at the rear. The most interesting feature of the bas-relief, however, is the clear depiction of spoked wheels in the handcarts which are bringing up the tackle — wheels which appear to be the same in essential detail as the wheel of today, and a great advance on the solid disc hacked from a log. But the bearings on which the wheel is carried have developed in a fashion which would have greatly eased the labour of the slaves of Nineveh.

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DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

British and American Productivity

In recent years the annual percentage increase in productivity for all British industries has not only been less than that of the United States of America but has also been less than that achieved in several European countries. Unfortunately, it is not possible to segregate the figures for a specific industry to allow a direct comparison between the British and American automobile industries, but there is not the slightest doubt that all in all the productivity norm in America is much higher than in this country.

So far as production engineering is concerned, the automobile industry is the most advanced, the most efficient and the most adventurous of British mechanical engineering industries, and it is therefore of interest to consider the reasons for the difference in American and British productivity levels.

Various reasons are often advanced but they are seldom argued to a conclusion. There are people who say that the very much higher American output is by far the most important factor, and leave it at that. This is to evade and not to face the facts. Others, and with greater justification, point out that in America the man on the shop floor, far from opposing, positively welcomes innovations that will increase output per man-hour and that only too often the converse is true in this country.

Of these two reasons, the first is the more frequently quoted, but whether the facts support it, is another matter. On this question a booklet, "*Automation in North America*," recently published by Her Majesty's Stationery Office for the Department of Scientific and Industrial Research, is not without interest. The author, a D.S.I.R. staff engineer, spent six months during the winter of 1955-56 studying American automation developments. Many of his findings refer to the automobile industry.

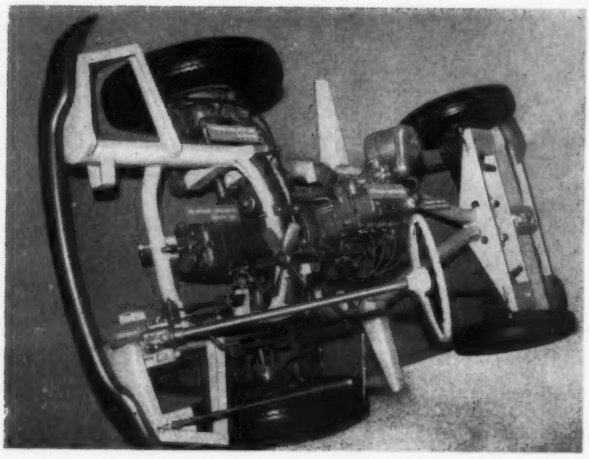
That, in general, the American automobile industry has carried automation to a pitch beyond that of the British industry is indisputable. Nevertheless, what we have garnered from the publication referred to above and from other sources convinces us that the difference is less than is commonly supposed, and is certainly not great enough to account for the known difference in productivity. There are, indeed, British developments, some of them more than five years old, that are still not equalled in the U.S.A. To quote only two, there are the Austin assembly factory at Longbridge and the Garrington press forge at Bromsgrove.

Probably, the greatest differences in productivity are met in foundry work and, to a lesser degree, in body manufacture. In each case the volume of output is a fairly important factor but developments now in progress in this country should, to some extent, redress the balance. For metal-cutting processes the differences are not generally so marked. In fact, an analysis of production cycle times for the various component parts of an engine suggest that, broadly, there is no substantial difference between the achievements of the major British producers and those of most of the American producers. It must, however, be admitted that in one or two American factories complete re-tooling that has been carried out in the past two years has led to a much higher output per hour than obtains generally in America or at all in Britain. However, although the machine cycle time, say for a cylinder block, may be approximately the same in both countries, a greater degree of automation is employed in America; as a consequence, the direct labour is less but not of an order that will fully account for the difference in man-hour productivity.

The human factor is, of course, one of the great imponderables in any consideration of the question of productivity. It does seem however, that the American approach to problems raised by advances in production engineering are different from the British approach. For example, American industries seem to employ on the factory floor more professional engineers of high standard than do comparable British firms, and they give production engineers as high a status as that enjoyed by their other professional staff. Furthermore, the American automobile industry gives its operatives more specialized technical training at advanced level than is usual practice in this country. The Chrysler Corporation, for example, runs its own Institute of Engineering in Detroit. This comprises an undergraduate school, offering courses similar to British National Certificate courses, and a graduate school authorized by charter to award a higher degree—Master of Automotive Engineering. As a result the people employed at foremen and superintendent level seem to have a better theoretical training than is common in British automobile plants. The developments now taking place in Colleges of Technology should lead to an improvement in this respect.

Probably the most important single factor is the trade union attitude to automation. In America there is no appreciable opposition to its introduction. There are frequent strikes for more pay but few against new machines or fresh methods. Indeed North American workers are much more likely to go on strike if their automatic equipment breaks down and they have once more to load and unload their machines by hand.

A similar spirit must be engendered in this country if productivity is to be increased by the fullest possible use of production resources—a matter of vital concern not only to the industry but also to the whole British economy.



Above: This installation of the Austin engine in the Tempo chassis is indicative of a trend away from the employment of low-powered engines in this type of vehicle. Interesting features of this particular installation are the mounting of the engine behind the seats for the driver and passenger, and the front-wheel-drive transmission arrangement

GERMAN COMMERCIAL VEHICLES

Some of the Latest Developments and Trends

Right: The occupants of the cab of the Borgward, 1½ ton, front-wheel-drive vehicle have an exceptionally good range of visibility

BECAUSE of Germany's geographical circumstances, that is, its central position in the European Continent, road and rail transport are of great importance there. The increasing tempo of mass production industries, and the consequent demand for delivery of components and materials to supply these industries at regular short intervals, has tended to favour road transport, which does not suffer from the drawback of time losses owing to shunting and transference from one vehicle to another for delivery from door-to-door.

Competition in the German commercial vehicle market is at present extremely fierce. This is partly because there is in that country a large number of heavy commercial vehicle manufacturers, nearly all with a high production capacity, and partly because the recently introduced legal restrictions with regard to overall dimensions and axle weights are so obviously impracticable that operators are convinced they will be changed before they are due to come fully into effect in 1960: as a result, purchases of commercial vehicles are being postponed wherever possible until customers are sure that their new vehicles will conform with the revised regulations. The principal objection to the current regulations is that in two years' time, over 60 per cent of the vehicles currently in use will not meet the requirements that are due to come into force then. Undoubtedly these conditions are leading, at least temporarily, to even greater efforts than ever before by German manufacturers in the export field.

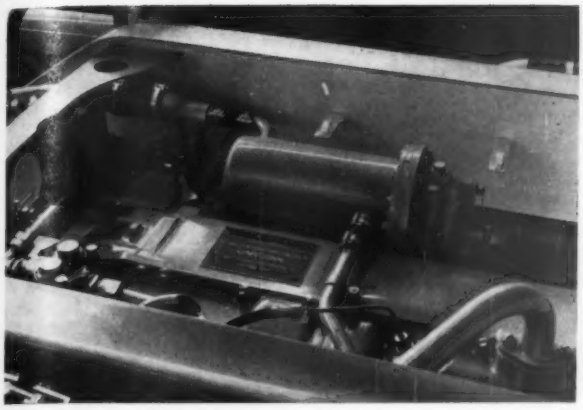
The fact that heavy commercial vehicles are now so difficult to sell in Germany has temporarily led to the financial embarrassment of the manufacturers of this class of vehicle in that country. However, rumours that were current at the time of the Frankfurt Show, to the effect that two of the largest and best known German manufacturers were about to go into liquidation, proved to be unfounded.

Paradoxically, the present difficult situation has expedited certain developments. Among the latest is a chassisless bus, with air suspension, introduced by Büssing. This is the first bus without a separate frame to be constructed by this Company. Underfloor engines, mounted amidships, are employed for the first time by M.A.N., Mercedes-Benz and Krauss-Maffei. Hitherto, these three manufacturers have favoured the rear-engine layout. The Krauss-Maffei underfloor-engined bus is powered by a Büssing water-cooled unit instead of the Deutz air-cooled units with which the other passenger-carrying vehicles of this Company are equipped.

Another trend is towards the employment of underfloor engines for trucks. A noteworthy example of this type of design is the Henschel HS 90. It is also significant that the B.M.C. A35 and A50 engines have been adopted to power the Tempo Viking Rapide and Matador vehicles respectively. Apparently, there is a demand for these more powerful units, particularly in the passenger-carrying versions of these vehicles, because they provide better acceleration.

Improvements continue to be made in cab design, particularly with regard to those features that affect driver comfort. A great deal of attention has been paid to noise reduction. Some cabs are trimmed with perforated hardboard, backed by a noise-absorbent material, such as glass wool. All-round visibility is receiving special attention. The cab of the new Borgward 1½ ton vehicle is a good example of this trend. Interior as well as exterior styling also are regarded by some manufacturers as important. An unusual instrument panel arrangement can be seen in the accompanying illustration of the interior of a Magirus Deutz cab.

An outstanding development is, of course, the widespread introduction of air suspension. This subject has already been discussed in detail in the December 1957 and January 1958



Oil-water heat exchanger on the Büssing LU7 underfloor-engined chassis

Three-point pivot mounting employed for the intermediate bearing for the propeller shaft of the Büssing LS 5 truck

issues of *Automobile Engineer*. The coil spring suspension systems that were introduced at the Frankfurt Show two years ago have, in many instances, been further developed and are currently offered as standard equipment in a number of vehicles.

Borgward and Büssing

Borgward G.m.b.H. have come into line with most of the other Continental manufacturers by introducing a 1½ ton vehicle that is designed specifically for commercial applications instead of being a modified version of the private car chassis. In this vehicle, front-wheel-drive has been adopted to enable a low floor level to be obtained in the rear portion. A low floor is, of course, almost essential for vehicles such as small buses, in which headroom is important, and it is certainly desirable even for purely goods-carrying vehicles. Forward control has been adopted to enable the largest possible floor area to be obtained in the load-carrying part of the body.

This vehicle is offered in three standard forms: one is a drop-side truck, another a van, and the third is a twelve-seater bus. It can be equipped with either a 1·75 litre diesel unit or a 1·5 litre petrol engine. The assembly comprising the engine, gearbox and radiator is mounted on a detachable frame that can be wheeled away from the remainder of the vehicle for maintenance purposes. Independent suspension is employed for all four wheels, the coil spring and wishbone layout having been adopted. In the truck cabs, a wide rear window is incorporated and the rear corners are glazed. A one-piece curved windscreen is also employed, so the all-round visibility is exceptionally good.

Among the latest designs by Büssing-Nutzkraftwagen G.m.b.H., of Brunswick, is the LS 5 truck chassis, intended for an all-up weight of 9,300 kg. Its carrying-capacity is approximately 5,200 kg. The chassis has a wheelbase of 4,300 mm, a track of 1,665 mm and an overall length of 7,165 mm.

This model is powered by a type S 5 diesel engine of the six-cylinder, in-line, four-stroke water-cooled layout. The bore of the engine is 96 mm and the stroke 125 mm, giving a swept volume of 5·43 litres. A power output of 110 b.h.p. at 2,600 r.p.m., according to the DIN 70 020 specification, is quoted. This represents 119 gross b.h.p. by the S.A.E. rating. The maximum torque of 34 kg-m is developed at 1,600 r.p.m.

A large, edge type, self-cleaning oil filter is installed in addition to the normal felt element filter. At the front end of the crankshaft there is a Mecano torsion vibration damper. As is standard practice on the Büssing vehicles, the radiator and fan are fully shrouded, the fan being a six-bladed cast aluminium unit.

Among the other interesting details of this chassis is the three-point, rubber-bushed mounting for the intermediate bearing of the propeller shaft, which is shown in an accompanying illustration. All three of these bushes are installed transversely relative to the chassis frame and their axes are parallel. Thus, the mounting has greater flexibility in the transverse direction than in the fore and aft and vertical directions.

Conventional semi-elliptic springs are employed both for the front and rear axles. At the rear, semi-elliptic helper springs are incorporated and when they come into operation their ends come up against rubber stops. The bump stops for each axle are of square section. They have vertical holes in their centres to receive their holding down bolts and to give a hollow rubber spring characteristic. Each spring has an eye at its front end and a slider arrangement, instead of a shackle, at the rear. Two leaves project into the slider, the end of one of them being bent down through 90 deg to prevent the spring from jumping out of its slider under excessive rebound conditions during operation over rough terrain.

Mann und Hummel G.m.b.H., of Ludwigsburg, make this air intake filter

Left: The Ford FK 1000 bus with the step, under the side door, in the fully retracted position

Below: In the Ford FK 1250 truck cab, the engine is installed between the two seats

Below: Ford FK 1000 bus with the step lowered and the side door open to show the arrangement of the bulkhead between the front and rear compartments

There are two features of interest on the LU 7 underfloor-engined chassis. One is that an oil-water heat exchanger is installed on top of the engine. This is to obtain a relatively rapid warm-up under very cold conditions. The other is that the radiator installation is unusual because of the restricted space available. A fully-shrouded, seven-bladed fan is employed, and its blades have an unusually large chord. The hub diameter also is large and the tip clearance is only a little over $\frac{1}{8}$ in. The radiator is mounted well forward of the engine and the fan is driven by a belt from the front end of a shaft equipped with two Layrub couplings. The rear end of the shaft is, of course, coupled to the crankshaft.

Clean air is taken from a point well forward of the front wheels, through a large rectangular duct to the radiator and thence into a collector box immediately behind the radiator. The fan is mounted in a sleeve, or shroud, on the rear face of this box. Presumably, the object of the collector box is to ensure that a uniform distribution of air flow is obtained throughout the whole of the radiator. Evidently the arrangement is very efficient, because the radiator is of relatively small proportions.

The standard version of the TU 5 has semi-elliptic springs at the front and rear, but the TU 5S is equipped with an air suspension system, described in the December 1957 issue of *Automobile Engineer*. Both versions are of integral construction. An underframe is employed to carry the mechanical components, so that the chassis can be driven under its own power to the body-builders. This frame, however, has to be integrated with the body to make the structure adequate to carry the normal operating loads. The vehicle is powered by the six-cylinder underfloor diesel engine, type U 5. This engine has the same cylinder dimensions, output and torque as those of the S 5 unit, already mentioned.

Ford and Eylert

An interesting detail of the German Ford front axle designed for a maximum load of 2·8 tonnes is the steering damper, which is shown in an accompanying illustration. At each end of the track rod there is an assembly comprising four circular friction pads, spring-loaded between steel leaves fixed alternately to the wheel hub and the track rod. A coil compression spring round the lower end of the pin that holds the assembly together provides the preload, which can be adjusted by means of a nut on the threaded lower end of the pin.

Ford-Werke A.G. have recently introduced the FK 1250 pick-up truck. Apart from the fact that the body of this truck is integrated with the cab, it closely resembles the larger range of trucks, in that it has drop sides and a tail board that also can be let down. A noteworthy feature of this vehicle is that it is of the forward control layout, the engine being well back between the two seats in the cab. The only obstruction on the cab floor is a forward-extending tunnel, which is part of the air duct to the radiator. To enable the engine to be installed so far back, the rear panel of the cab, which also forms the front panel of the pick-up body, is made in two pieces. The lower piece, below the waist rail, is set back about $1\frac{1}{2}$ in and is dished to a depth of approximately $1\frac{3}{4}$ in at the centre. A deep pressed cover, hinged at its forward end, is fitted over the engine in the cab.

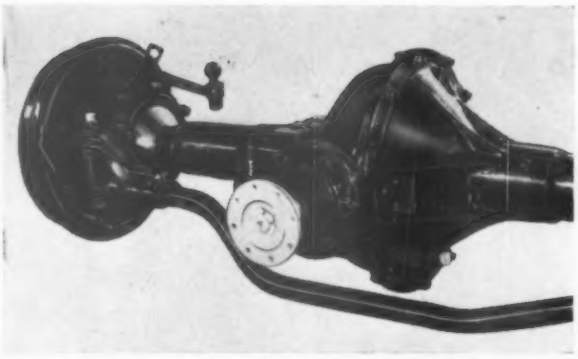
A noteworthy feature of the installation is a push-pull control for the radiator drain cock. The engine sump is behind the cross member that carries the front suspension. There are two seats, mounted one over each wheel arch.

Other features of the cab layout are as follows. The headlamps are mounted in apertures in the front panel, their reflectors and electrical connections being protected by dished pressings assembled over them inside the cab. The left-hand one is further protected from damage by the steering column, which is immediately behind it, and a cross bar is fitted behind the right-hand housing. This cross bar, which forms a foot rest for the passenger, is

attached at one end to the tunnel and at the other to the scuttle side-panel. As can be seen from the accompanying illustration, this arrangement gives exceptionally good accessibility for service. The toeboard is pressed locally round the foot of the steering column, to clear the steering box.

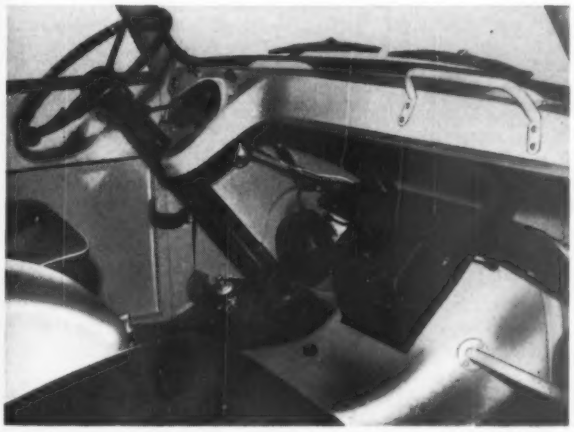
With a forward control layout, the heater installation presents some difficulties. In this vehicle, the problem has been solved in a most economical manner. The heater is mounted on the forward end of the radiator tunnel in the cab. As can be seen from the accompanying illustration, a horizontal duct extends laterally on each side of the unit to distribute warm air over the feet of the driver and the passenger. Flexible hose connections are taken from these ducts to the two demister apertures on top of the facia. The unit is equipped with a three-position valve, the positions being off, defrost, and demist and interior heat. A flap in the rear wall of the housing for the heater can be opened to allow fresh air to by-pass the heater element and come directly into the cab. A water valve control knob is mounted on the tunnel, immediately behind the heater. An electric fan is mounted in the base of the heater unit and takes air from the channel leading to the radiator.

The duct to the radiator is completed by a channel of approximately inverted top hat section, mounted under the tunnel. At first sight, it might appear surprising that the radiator is served by a completely enclosed duct. However, the reason for this is obviously that the space available for the radiator is unusually restricted and that a highly efficient ducting system is therefore necessary in order that a radiator of the smallest possible size can be used. The hand brake is of the pull-up, pistol grip type, and is mounted on the tunnel.



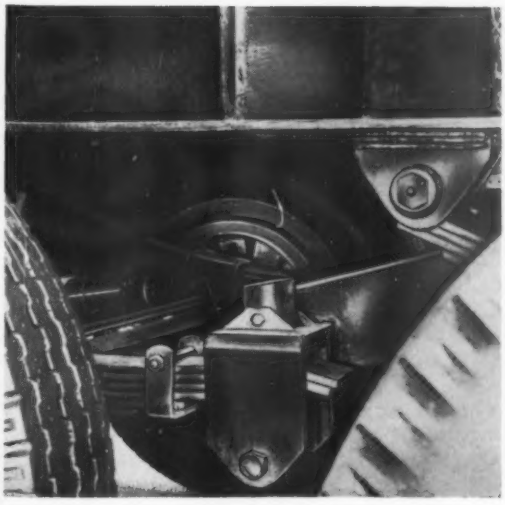
A steering damper of the friction type is incorporated at each end of the track rod of the Ford front axle designed for a maximum load of 2·8 tonnes; each damper is adjustable by means of a split-pinned nut

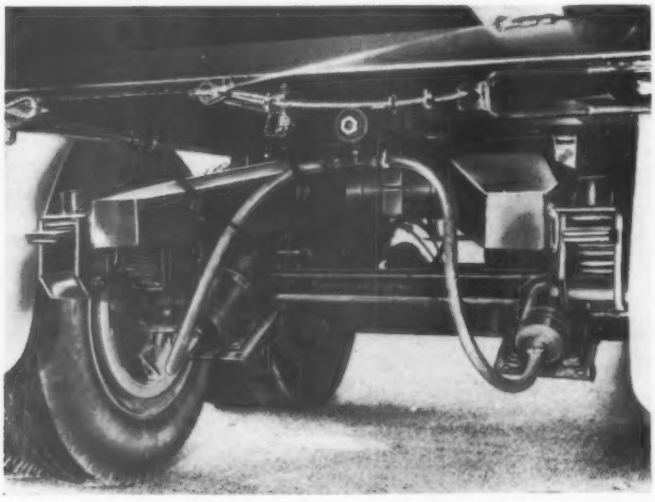
This vehicle is powered by the 1½ litre Taunus 15M engine. The gear ratios are 4·23 : 1, 2·47 : 1, 1·57 : 1 and 1 : 1. A reverse ratio of 5·41 : 1 has been adopted. These ratios are also common to the FK 1000/1·5 and FK 1000 models. An axle ratio of 5·14 : 1 has been adopted for both the FK 1250, and the FK 1000/1·5, but that for the FK 1000, which has a 1·2 litre engine, is 5·83 : 1. All the following dimensions are common to the three models. The wheelbase is 2,300 mm, while the track is 1,340 mm at the front and 1,360 mm at the rear. An overall length of 4,300 mm is quoted, the width is 1,740 mm, and the unladen height is 1,965 mm. A loading platform 2,600 mm long × 1,600 mm wide has been adopted. The unladen weights of the vehicles are 1,150 kg for the FK 1250 and FK 1000/1·5, and 1100 kg

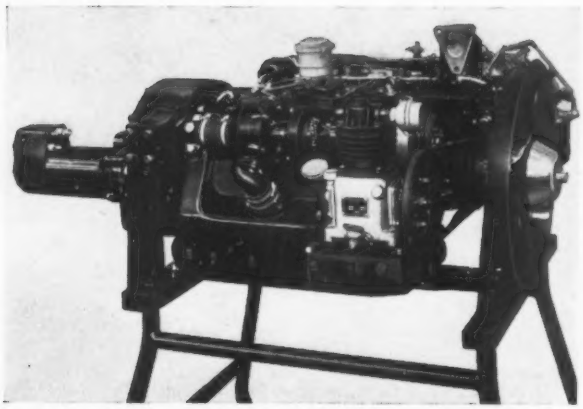


Left: Installation of the heater in a readily accessible position on top of the radiator duct in the Ford FK 1250 pick-up truck cab

Below: Two views of the Eylert trailer axles and their semi-elliptic springs, the trailing ends of which bear in slider brackets on the ends of a centrally-pivoted cruciform link mounted under the chassis frame

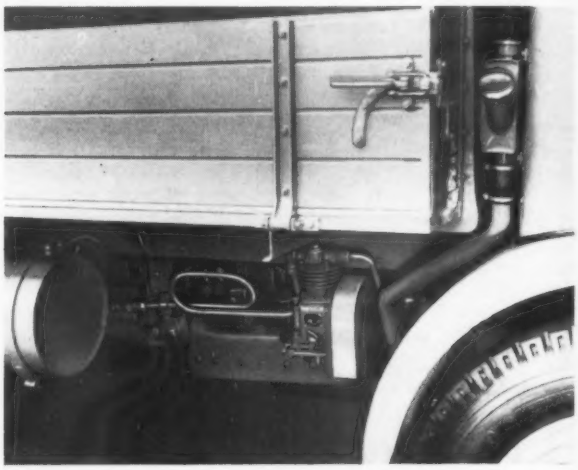






Left: The 90 b.h.p., compact underfloor engine used in the Henschel HS 90 truck, which is illustrated at the foot of the opposite page

Below: Because of the restricted space for the radiator in the Henschel underfloor-engined truck, the header tank is mounted between the cab and body, where it is readily accessible for checking and topping up



for the FK 1000; the laden weights are 2,400 kg, 2,150 kg and 2,100 kg respectively.

A new version of the FK 1000 vehicle was exhibited at the 1957 Frankfurt Show. It is a bus, with a seating capacity of 11, including the driver. There is a bench type seat for three at the rear, and forward of it are two pairs of seats, one in front of the other, arranged so that there is a gangway along the side adjacent to the door. Another seat folds up against the side, immediately behind the door. The ninth seat behind the bulkhead separating the rear compartment from the front is alongside the forward pair of seats. It can be swung forwards on hinges to make room for the passengers passing through the door to the seats behind it. Of the two seats forward of the bulkhead, one is, of course, for the driver.

As can be seen from the accompanying illustration, there are two doors forward of the bulkhead, one on each side, and a third immediately behind the door on the right-hand side. All the doors hinge on the pillars at the ends of the bulkhead. A noteworthy feature in connection with the third door is that the pin that secures the check strap to it can be removed so that the door will fold right forward until it is almost flush with the side of the vehicle. Movement of this door is limited by a rubber stop mounted on the front door. The pin is secured to the door by a piece of cord, so that it will not get lost. There is also a door at the rear end of the vehicle.

Henschel underfloor-engined truck, with the engine cover on the left-hand side swung downwards about the hinge that secures its lower edge

The window arrangement is as follows. Each of the front two doors has two horizontally-sliding panes of glass. The next two windows behind on each side have sliding forward panels, while the rear panels are each hinged at their front edge and have a toggle fastener at their trailing edge, so that they can be opened to give draught-free ventilation. The two rear quarter lights are curved and, like the rear light, are, of course, fixed. There are three transparent panels immediately above the cant rail on each side, and a sunshine roof with a canvas cover.

Another feature of this vehicle is a hydraulically-actuated, retractable step under the door sill at the side of the rear compartment. A single movement of a lever in the driver's compartment brings the step downwards and out from its retracted position. To assist people getting into the front three seats of the rear compartment, a grab handle is fitted to the top of the bulkhead, that is, at waist height. A shelf, or table, is also mounted on the rear face of the bulkhead.

The specification of this vehicle is much the same as that already given for the FK 1250. Its unladen weight is 1,150 kg and its laden weight is 2,150 kg. This particular version of the FK 1000 vehicle is powered by the 1·5 litre Taunus engine, instead of the 1·2 litre unit.

At the 1957 Frankfurt Show, a trailer manufactured by Eylert K-G., Fahrzeugfabrik, of Wuppertal-Sonnborn, was exhibited on the Ford stand. An interesting feature of this vehicle is the suspension of its two rear axles, which is shown in the accompanying illustrations. Both axles are mounted under semi-elliptic springs. Each spring has an eye at its forward end, by means of which it is secured to the hanger

bracket below the frame. The trailing ends of the springs bear on slider pads mounted on the ends of a centrally pivoted lever. As viewed in plan, this lever is of X-shape and its pivot is above the rear axle. Thus, the two forward-extending arms carry the trailing ends of the springs of the forward axle and its two rearward-extending arms carry those of the rearmost axle.

It is of interest to compare this arrangement with the short rocker arm layout more commonly adopted, in which the ends of the rockers carry adjacent ends of the springs, that is, the trailing end of the forward spring and the leading end of the rear spring on each side. The rocker lever on the Eylert trailer is large, and therefore both heavy and costly. On the other hand, because of the length of its arms, a much larger amplitude of motion of one axle relative to the other is possible than with the short rocker arrangement. This probably enables the trailer to ride better over very rough terrain. Also, because of the large radius of the arc through which the lever oscillates, the relative motion between the slider pads and the spring ends is small, so presumably the rate of wear is low.

Henschel

Perhaps one of the most significant developments in Germany is the introduction of the new Henschel HS 90 truck, with a horizontal underfloor engine. This vehicle has all the advantages but none of the disadvantages of a more conventional forward control truck. In other words, not only is the range of vision from the cab exceptionally good and the optimum space available behind, for the load-carrying platform, but also, as can be seen from the accompanying illustration, the cab floor is completely unobstructed, and furthermore, noise in the cab is reduced to a minimum, and there is no danger of engine fumes reaching the interior.

Most of the horizontal engine is behind the cab, but some of it does project under the bench type seat for three. It is a four-cylinder unit, developing 90 b.h.p. Because of its short length, there is adequate space behind for the installation of tipper gear if required. All the components likely to need servicing attention are accessible from the sides and below. A hinged cover is fitted over the left-hand side of the engine to keep the injection equipment clean. The compressor, dynamo, water pump and starter are mounted on the right, above the sump. Because of the small amount of space available for the radiator, the header tank is mounted separately between the cab and truck body, where it is readily accessible for filling.

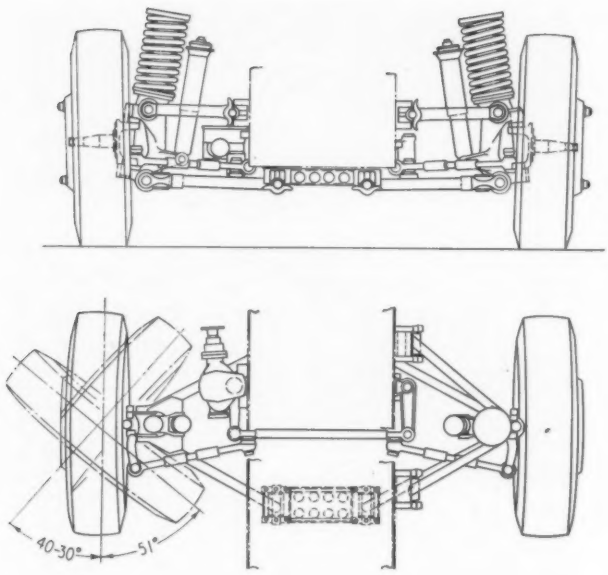
In the design of this vehicle, special attention has been devoted to catering for modern traffic conditions. The turning circle is only 12 metres. This is obtained with a wheel lock of 50 deg and a wheelbase of 3·10 metres. The overall length of the vehicle is 5·9 metres and the loading platform is 4·200×2·050 metres.

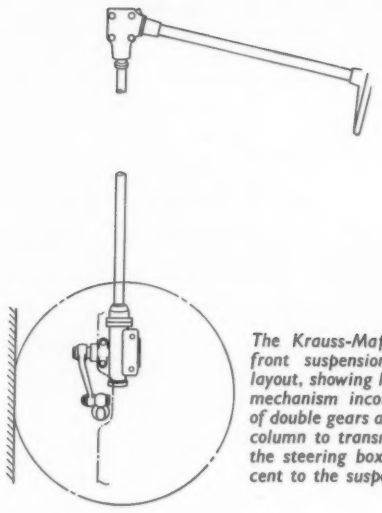
A noteworthy feature of the cab of the Henschel underfloor-engined truck is its unobstructed floor and relatively clear range of visibility

Krauss-Maffei

The Krauss-Maffei KMS 125 vehicle is supplied in different forms for town bus services, suburban routes and long-distance touring. It is powered by the Deutz, air-cooled, F6L614 diesel unit, developing 125 b.h.p. at 2,300 r.p.m., installed at the rear. This vehicle is of integral construction, the side panelling being of steel and the front, rear and roof of a corrosion-resistant aluminium alloy. This form of construction combines light weight, stiffness and strength.

The Henschel HS 90 truck has been designed for good manoeuvrability and ease of parking in congested traffic conditions in towns





The Krauss-Maffei independent front suspension and steering layout, showing how the steering mechanism incorporates a pair of double gears at the base of the column to transmit the drive to the steering box mounted adjacent to the suspension assembly

Conventional semi-elliptic springs are employed at the rear, but a double transverse link type, independent system is installed at the front. This system was exhibition in mock-up form at the 1955 Frankfurt Show, and was illustrated in the November 1955 issue of *Automobile Engineer*. The accompanying line drawings show a few more details. Hollow rubber assister springs are mounted coaxially in the coil springs. These assister springs, of course, also act as bump stops. Both springs on each side are mounted on a platform on the stub axle carrier forging. The principal advantage of this is that the loads due to spring and bump stop reactions are not transmitted through the transverse links to the bearings. This not only increases bearing life but, since in the Krauss-Maffei vehicle these bearings are rubber-bushed, it also avoids trouble due to unwanted deflections. The telescopic hydraulic shock absorbers are connected to the stub axle carrier forgings. Maintenance work is reduced to a minimum by the employment of rubber bushes in both the front and rear suspension attachment points.

The steering arrangements are of interest in that there is a pair of bevel gears, instead of the steering box, at the base of the column, through which the motion is transmitted to a horizontal shaft. This shaft is connected to the steering box, which is mounted above the three-piece track rod. With this arrangement, the correct steering geometry is obtained and steering movements, due to the bowing of the rods between the steering column and the wheels, are minimized. Presumably, it has been adopted to improve handling characteristics and reduce tyre wear. A similar arrangement is employed on the M.A.N. 420 HOC1, but in the M.A.N. vehicle the steering box is mounted on the beam axle, instead of on the vehicle structure, and therefore a sliding joint has to be incorporated in the shaft.

Magirus-Deutz

Interesting interior layout arrangements and trim details are incorporated in the range of vehicles by Magirus-Deutz, of Ulm-Donnau. The type O 3500 H bus is powered by their six-cylinder, V-type, air-cooled engine, which is installed at the rear. A noteworthy feature of a recently exhibited long-distance touring version of this vehicle is the adoption of brightly contrasting colour schemes for the interior trim. It would appear that the inspiration that has led to the employment of this form of decoration has come from modern architecture, and there can be little doubt that the bright colours could be particularly attractive in sunny climates, where the pastel shades and more sombre colours tend to look rather flat and monotonous.

The seats of this vehicle are covered with black cloth, trimmed with cream leathercloth round the edges, and decorated with cream piping. The bright colours are provided by square head-rest cushions, of foam rubber, covered on one side with a lemon yellow and on the other with a light red. In the vehicle displayed, these were arranged alternately with their red and yellow sides uppermost. Yellow curtains were fitted to the windows. The side panel trim was cream and the head-lining grey. A red and black floor covering was employed. The colour scheme for the exterior was principally three shades of blue.

A sober and practical example of interior layout and trim is that of the Saturn F, forward-control cab. As can be seen from the accompanying illustration, the instrument panel is of rectangular, dished form, arranged in such a way that there is no danger of reflections on the screen at night. To the right of this panel is an indicator, used in conjunction with the ZF pneumatically-actuated gearbox, to show which gear is engaged. An unusual feature of the instrument layout is a very large red warning light to indicate when the engine temperature is too high; a conspicuous warning device presumably is an essential feature with an air-cooled engine.

This vehicle is one of a number of German manufacture that have an unusual form of noise-absorbent trim. Wherever possible, the interior panelling is in the form of hardboard with rows of perforations about $\frac{1}{8}$ in diameter by $\frac{1}{4}$ in pitch, and approximately $\frac{1}{4}$ in apart. Behind this is a glass wool, noise-absorbent padding. On panels of double curvature, such as the roof, the corners are generally mitred and the joints concealed by means of an aluminium strip. As can be seen from the accompanying illustration, the roof trim panel in the Saturn F cab is in three pieces.

This type of acoustic treatment has been employed widely in buildings and also was adopted a year or two ago in some American private cars. In the cars, hide or leathercloth is used instead of the hardboard. No doubt the type of hardboard used influences the results obtained, since the acoustic properties of this material vary considerably as between different grades. The object of this treatment is, of course, to prevent reverberation, as well as to provide insulation.

The cab will seat four people. It has a separate seat for the driver on one side and for one passenger on the other

side, and between the two is a bench type seat mounted over the engine cowl. A footstool is provided for the two occupants of the bench type seat because of their relatively high position. It would appear that if the crew comprised only two persons, the seats to the right of the driver would form a tolerably comfortable bed for one.

Large rubber clips hold down the engine cowl, as can be seen from the accompanying illustration. The use of rubber for these clips obviates the need for a separate spring and ensures that there is no possibility of rattles developing. Another interesting detail feature of the cab is the large semi-circular jets to distribute the demisting air flow over the screen. These jets are fabricated from two pressings, one of quarter-spherical form and the other a semi-circular baffle. The semi-circular baffle is near the screen and the quarter-spherical pressing is immediately behind it, the gap between the two forming the jet. There are two of these assemblies mounted on top of the facia, as shown in the illustration of this cab at the top of the right-hand column of this page.

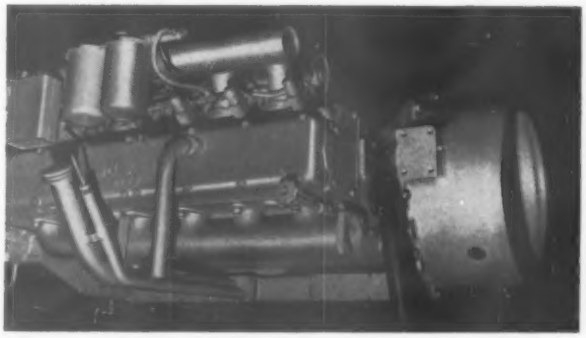
Because of the relatively high position of the seat over the engine cowl in the Magirus-Deutz cab, a footstool is provided

M.A.N.

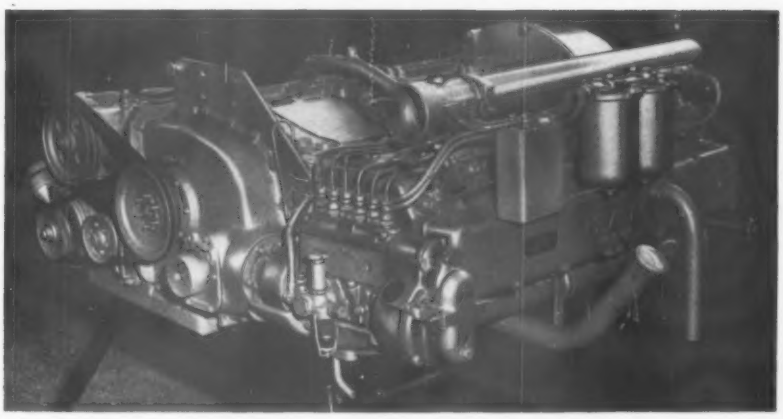
Maschinenfabrik Augsburg-Nurnberg A.G., of Nurnberg, have recently introduced a new six-cylinder underfloor engine, which is designated type D 1546 M1U, and which develops 160 b.h.p. The swept volume of this unit is 8,725 cm³. The illustrations of this engine show details of the layout, which therefore does not require further explanation. However, an interesting feature that is worthy of special note is the arrangement of the sump. This component is a casting, the lower portion of which is extended laterally, on one side underneath the cylinder block, and on the other side it extends to form a shelf on which the dynamo and water pump are mounted. The upper joint face is secured in the usual manner by relatively short set bolts, but long set bolts are passed through the crankcase to tighten down the lower joint face which, of course, is not below the oil level.

There are one or two unusual features on the 420 HOC1, bus type chasis. For example, the steering box is mounted on a bracket bolted to the centre of the axle beam, and it is connected by a shaft to a bevel gear pair at the bottom of the steering column. This shaft has a universal joint at each end and a sliding joint at the front end. The object of this arrangement is to obviate steering interference owing to axle deflection. Both front springs have slider type end-fittings. Location is effected by the bottom two leaves, which are extended forwards clear of the main portion of the spring; the ends of these pairs of leaves are turned over to form eyes, which are pinned between lugs extended downwards on each side of the slider pad. The advantage of this

Left: Instrument panel and control layout of the Magirus-Deutz Saturn F forward-control cab



Right: M.A.N. six-cylinder underfloor engine viewed from below, to show how the sump extends under the block



Right: Injection equipment, fuel filters and oil filler tube are in an accessible position on the left-hand side of the M.A.N. D 1546 M1U, six-cylinder underfloor diesel engine

On the M.A.N. 420 HOC1 bus chassis, the ends of the semi-elliptic springs of the rear suspension are carried in slider brackets, and the axle is located by radius arms, which are splined on to an anti-roll bar

arrangement is that the shear loading of the portions of the leaves adjacent to the eyes is light and the possibility of failure is reduced. Also, since the bushes are not required to transmit heavy vertical loads, they can be relatively light.

The rear suspension is also of the double slider type, but location is effected by two leaf type leading links, attached one to each end of the axle beam. The rear end of each link is pivoted between lugs on the spring seating pad bracket. Both are splined on to a common pivot pin, the dimensions of which are such that it serves as an anti-roll bar to improve the cornering characteristics of the vehicle. Under drive loading, these links are in tension, but under braking conditions they are in compression. Although, as can be seen in the illustration, they are relatively slender, they are, nevertheless, adequate to take these loads.

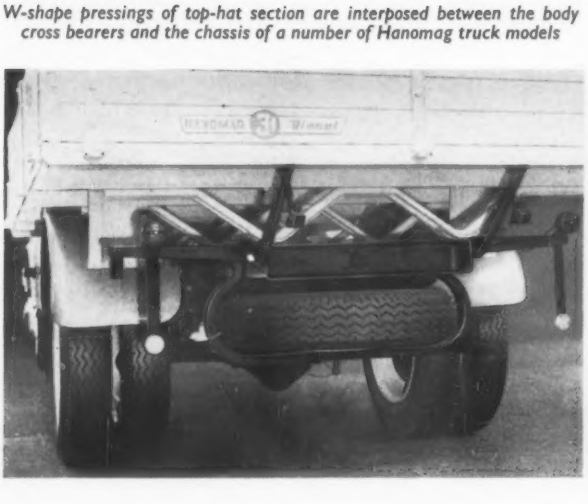
Shallow channel section seats for the ends of the springs are carried in brackets on the frame. They are of convex curvature, as viewed in side elevation. A separate seating pad is secured on top of each end of the springs, and these pads slide in the channel sections above them. All the wear is taken by these seating pads, which can be easily replaced.

Another unusual feature of the chassis, but common to most if not all the M.A.N. vehicles, is the rear axle construction. The axle comprises an I-section beam with a large eye at its centre, in which is carried the bolted-on final drive casing. There are two separate axle tubes of very light section, forward of the I-section beam. Their function is

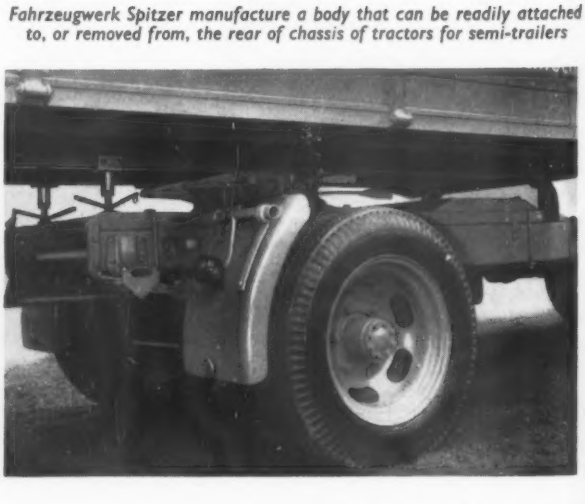
Front suspension and steering layout of the M.A.N. 420 HOC1 chassis

Left: The deep transparent panel in the door of this Faun cab is a useful feature for vehicles operated on civil engineering sites liable to be littered with big obstructions

W-shape pressings of top-hat section are interposed between the body cross bearers and the chassis of a number of Hanomag truck models



Fahrzeugwerk Spitzer manufacture a body that can be readily attached to, or removed from, the rear of chassis of tractors for semi-trailers



All-round visibility for the driver and passengers is a noteworthy feature of the Neoplan coach, which has a large luggage compartment under the floor of the rear portion of its light-weight 1½-deck body

to protect the half shafts and mechanism from foreign matter, and to carry the lubricant passing between the reduction gear housings. The final drive in this particular chassis is of the double-reduction type, the second reduction being effected in the wheel hubs. The engine is installed behind the rear axle.

Mercedes-Benz

Like many of the German manufacturers, Mercedes-Benz have introduced multi-fuel engines. However, Prof. Dr. Ing. h.c. Fritz Nallinger, director and chief engineer of that organization, has stated that his firm takes the view that these engines are justified only for military purposes and are hardly likely to be competitive with pure diesel engines in the economic and commercial field.

Mercedes-Benz have developed their multi-fuel units from their OM 321, OM 315 and OM 326 engines. These units can be run even on fuels of high aromatic content, without any limitation of the octane rating and without the addition of oil or gas-oil. Among the kinds of fuel usually employed are: normal petrols, super petrols, military grades of fuel and petrol-benzol mixtures; these fuels cannot, however, be used for starting. Other fuels, such as those used for jet propulsion units, engine kerosene, normal diesel fuels and lubricating oils can be used.

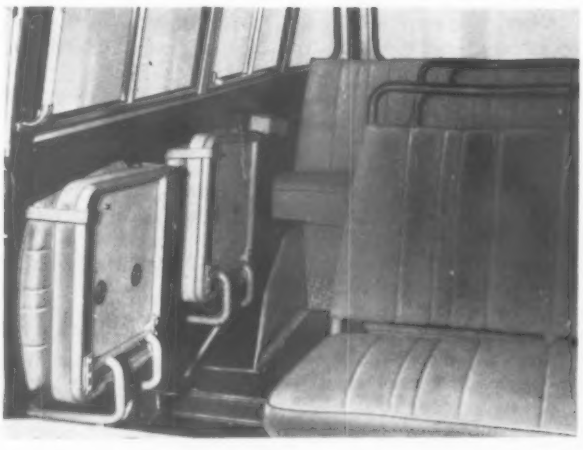
Measurement of the pressure distribution in the combustion chamber and pre-chamber, with reference to the crank angle, have shown that these engines operate almost free from diesel knock, even with the less favourable fuels. The outputs of the engines are the same regardless of whether they are operated on Megas or on gas oil, provided the injection rate is increased when Megas is employed. This latter adjustment is necessary because of the relatively low calorific value of Megas.

The manufacturers state that the engine can be started as easily as their pure diesel engines, even at temperatures as low as —4 deg F, and that special starting methods are unnecessary unless highly aromatic fuels are employed. If the coolant is pre-heated, the engines can be started at temperatures as low as —40 deg F, even if the battery is cold. It is also stated that as soon as the engine has fired, it can immediately be subjected to full load without smoke issuing from the exhaust.

Neoplan

The Neoplan coach, manufactured by Gottlob Auwärter, of Stuttgart-Möhringen, is noteworthy for the good all-round visibility not only for the driver, but also for the passengers. This vehicle is of the 1½-deck form of design, the lower portion at the rear being occupied by the luggage and the engine. It is powered by the Henschel 522 DPJ engine, which develops 125 b.h.p. or, with a blower fitted at extra cost, 145 b.h.p. The front axle all-up loading is 3,600 kg and the rear axle loading 7,800 kg. When empty, the vehicle weighs 7,750 kg. It is equipped with 9.00—20 e.H.D.

The three illustrations in this column show the interior arrangement of the Tempo bus, which is equipped with an Austin engine



tyres. The capacity for luggage is 4½ m³: this feature is useful for vehicles intended for long-distance touring on the Continent, since it obviates the need for a luggage trailer.

Inside the vehicle, the seats can be adjusted to the reclining position. The arm rests are readily removed, since their sole attachment device is a pair of taper spigots, which fit into tapered sockets on the seat pans. There are four, large, transparent roof ventilators of rectangular form. These are raised and lowered by means of a hand-wheel at each end, which actuates a worm-and-worm-wheel and elbow-joint linkage.

The vehicle has an exceptionally low waist line, which accounts for the good visibility. In fact, the waist line is only about 1½ in above the arm rests. Immediately behind the foremost portion, it is stepped up because the seats in that area are mounted on a platform that forms the wheel box. Behind this there is a third step up, to bring the waist rail up to the appropriate level in the rear portion of the vehicle, over the luggage compartment.

Spitzer

Fahrzeugwerk Spitzer K.G., of Mosbach, Baden, produce a drop-side body that can be mounted and removed from the rear of prime mover vehicles for towing semi-trailers. The body is based on a frame, at the centre of which is a pin to register in the jaws of the towing attachment on the tractor. Two struts, one at the front end of each of the side members of the frame, extend downwards to seat on the tractor frame side members. At the rear, there are two screw jacks, one under each body side member. These are screwed down against the upper face of the rear end of the tractor frame until the body assembly, pivoting about its central attachment, is firmly seated at its front end on the tractor side members.

Tempo and Hanomag

The Tempo Viking Rapid and Matador vehicles are now offered with the Austin A35 and A50 engines respectively. This reflects the demand for better performance than can be obtained with the smaller two-stroke engines, which are still available for those who want then. Both these vehicles can be supplied in any one of a wide variety of forms, such as high or low loader platform trucks of various dimensions, vans, buses, cattle trucks, and other special-purpose vehicles. In both instances, the Austin engine is mounted behind the front seats, with the gearbox in front of it to transmit the drive to the front wheels.

In the bus body, the seating arrangements are as follows. A bench type seat is employed at the front and a centre arm rest is fitted. Immediately behind this are two rows of double bench type seats and, at the extreme rear, a bench type seat for three people. Against the right-hand wall of the vehicle, in line with each of the two double bench type seats is a single seat that can be folded up against the body side, as shown in the accompanying illustration. There are two rearward-facing folding seats against the bulkhead that separates the driving compartment from the rear. Between these two seats, there is a removable cover, through which access can be gained to the engine. Front-wheel-drive is a considerable advantage for this type of vehicle, because of the very low floor level that can be obtained at the rear. The spare wheel is stowed under the rear seat, and there is a little room for luggage behind the rear squab.

The window arrangement is as follows. A toggle clip secures the front triangular glass ventilating panel, and all the other windows are of the horizontally-sliding type. Curved rear quarter glasses are fitted and the light on the rear door is also of the fixed type. Transparent panels are fitted on each side, immediately above the cant rails, and a fabric sunshine roof is incorporated. This roof fitment has a horizontally-sliding headrail that locks to the roof panel, just to the rear of the bulkhead, and three transverse hoop sticks, which also slide horizontally in two longitudinal rails, one on each side of the roof, and which are interlinked in such a manner that the fabric folds concertina-fashion. Twin roof ventilators are fitted behind the luggage net, which is fitted transversely between the cant rails above the bulkhead.

An accompanying illustration shows the method of body mounting employed on a number of the Hanomag trucks. Top hat section pressings are interposed between the cross bearers of the drop-side body and the vehicle frame. These top hat sections are bent into approximately W-form, the two angles at the base of the W being reinforced by plates welded to the flanges of the section. The advantages of this arrangement are that it is cheap, light, and presumably is good from the point of view of rationalization.

Porosity in Welding

THE problem of porosity is one which arises constantly in welding. Its effect in work subjected to X-ray inspection is well-known, but in work that is less strictly tested, visible porosity constantly necessitates laborious chipping-out and re-welding. Appropriate steps can, however, be taken to ensure porosity-free welds.

Often, the problem arises as a result of welding on greasy or painted plate. The plate should always be cleaned, at least along the line of the weld, before the welding operation commences. Plate that is very wet sometimes shows porosity, as does plate that is heavily rusted. This is particularly so if the rust has absorbed moisture. Wet plate should therefore be dried.

The correct choice of electrode plays an important part in the success of welding operations. A large variety of mild steel and special electrodes are now available for welding various metals and alloys, and for joining two different metals.

Despite considerable research into welding problems, it is still found that some metals are difficult to weld. In particular, free-cutting steel, which contains a fairly high proportion of sulphur, often gives porosity even when care is taken in both technique and choice of electrode. For the welding of free-cutting steel, a basic low-hydrogen electrode, such as Quasi-Arc Ferron, is advisable.

Porosity is also caused by dampness affecting the electrodes. Some coverings absorb moisture more easily than others, and where electrodes are found to be damp even despite careful storage, a drying oven should be used, which holds the electrodes at the correct temperature and avoids damage to the coverings by excess heat. Care in technique must always be exercised. In inert gas shielded welding processes, it is important to see that the correct gas glow is ensured before the welding operation commences. Insufficient flow or failure of the gas supply will result in serious porosity.

Trapped air or moisture in T fillets or at other unwelded interfaces can also lead to porosity. Where areas of porosity occur despite the exercise of perfect technique, this is due in many instances to the fact that air or moisture has become trapped in a fillet, or behind tacks in a joint which already has a backing run. Technical circulars dealing with both the electrodes and special techniques to combat porosity are available from Quasi-Arc Limited, Bilston, Staffs.

Roll Axes

General Considerations Relating to Roll About the Lateral and Longitudinal Axes, and Geometric Requirements for the Elimination of Roll Forward, or Brake Dive

W. Steeds, O.B.E., B.Sc., A.C.G.I., M.I.Mech.E.

THAT every suspension system has a roll axis is, of course, a conception of long standing. In fact, the term roll axis has been in use since the nineteen-twenties, and the conception, under a different name, is some fifty years old. Despite its respectable antiquity, the term has never been precisely defined and there still seem to be prevalent today some misconceptions in regard to it. It has been thought worth while, therefore, to examine the theory again.

To start with, the following definition of the roll axis is proposed. The roll axis of a suspension system is that axis about which the body of the vehicle will rotate when a pure couple, or moment, is applied to the body, the plane of the couple being perpendicular to the axis. On this definition, most four-wheeled vehicles will have at least two roll axes, one in the longitudinal vertical plane and the other in a transverse vertical plane.

Motion about the second of these axes is commonly referred to as the pitch axis. This term, however, is widely used to denote other transverse axes about which vibrations occur, so the use of the term transverse roll axis is preferable, especially since in many respects this transverse roll axis can be treated mathematically in the same way as the longitudinal one and has similar properties. Despite the fact that so far no definition of the roll axes has been published, there is general agreement on their positions and the method of determining them.

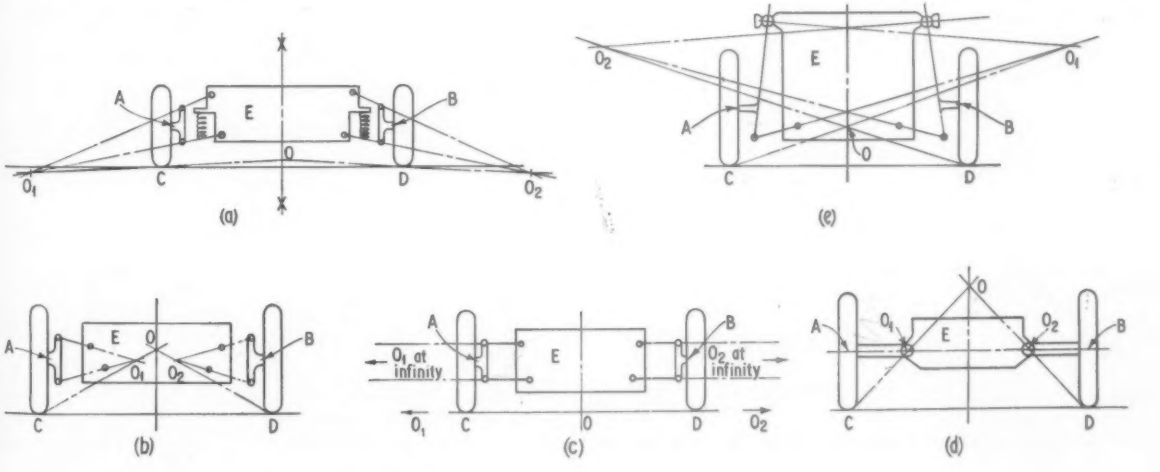
Geometric constructions for some typical suspensions are given in Fig. 1. In all of these, the point O_1 is the instantaneous centre of the stub axle A relative to the body E, and O_2 that of the stub axle B. The roll centre O is found at the intersection of the lines O_1C and O_2D, joining O_1 and O_2 to the points of contact, C and D, of the wheels and the ground. In all cases it is obvious that if the suspension system is symmetrical about the central plane XX of the vehicle, the roll centre O will lie in that plane. These constructions are, of course, based on the assumption that the deflections of the suspensions under the applied torque are very small and also that the effective stiffnesses of the suspension on each side are equal.

In the common double-transverse-link types of suspension, as shown in Fig. 1, at a, b and c, the centre O can be made, by suitably inclining the levers, to lie at any distance above or below the ground level. If the arrangements shown in Fig. 1 represent front suspensions, and identical suspensions are used at the rear, the heights of the points O′ and O above the ground will be the same at the rear as at the front, and therefore the roll axis OO′ will be parallel to the ground. On the other hand, if the rear suspension arrangement is such that the height O′ is different from that of O, then the roll axis will be inclined to the ground.

A suspension in which a beam axle is used is shown in Fig. 2. It is assumed that, so far as the relative location of the axle and the body is concerned, the springs are the only connections between them, and therefore the centre O is in the horizontal plane containing the points of attachment of the springs to the body. This location of O follows immediately from the definition of the roll axis given previously. However, if the roll axis is taken as the axis about which the body tilts under the action of side forces, there will be some uncertainty about the position of the point O; this is because there may be some lateral yielding of the springs, which will bring the point O to a lower position than that shown. The use of a Panhard rod, or transverse radius rod, or of equivalent mechanisms, will influence the position of the centre O.

It is when suspension systems subjected to horizontal side forces are considered that misconceptions regarding roll centres begin to arise. For example, it appears to be a

Fig. 1. Geometric arrangement of some typical suspension systems, and the graphical method by means of which their roll centres can be determined



commonly-held view that if such forces act through the roll centre, then the tilt of the body will be zero. However, for a symmetrical suspension, this can be shown to be true only if the horizontal side forces between the wheels and the ground at C and D, Fig. 1, are equal. This aspect of the matter will, therefore, be considered in some detail.

In Fig. 3, the disposition of the links has been chosen so as to make the diagram as clear as possible, but the analysis that follows can be applied to all possible arrangements by giving suitable values to the angles α and β.

A side force P acts at a height H, and is resisted by reactions kP at C and $P(1-k)$ at D. The force P and the reactions at the ground constitute a couple PH, and this can be balanced only by equal and opposite forces F and $-F$ at C and D. These forces are, of course, independent of the form of the suspension system and their magnitude is PH/L.

In the absence of the force kP, the force F could be obtained only by an upward movement of the stub axle A relative to the body, and similarly, in the absence of the force $P(1-k)$, the force $-F$ could be obtained only by a downward movement of the stub axle B relative to the body. That is, the forces F and $-F$ would involve an angular motion of the body in an anti-clockwise sense. However, when there

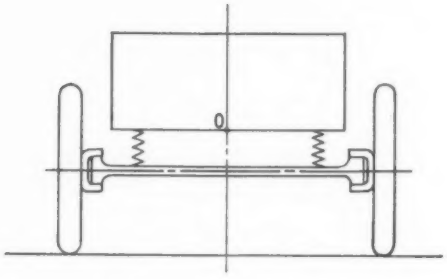


Fig. 2. Position of the roll centre O with a beam axle arrangement

are forces corresponding to kP and $P(1-k)$, it is possible, by suitably choosing the angles α and β, to obtain the forces F and $-F$ without any movement of the stub axles relative to the body and thus without any tilt of the body. It will be assumed that the angle α is chosen arbitrarily and the requisite value of β to give the required condition will be found. Since no motion of the stub axles is going to occur, the spring forces will be unchanged and these will balance the weight of the body: therefore, this and the corresponding vertical reactions at the wheel contacts can be left out of the analysis.

Considering the equilibrium of the left-hand stub axle and wheel assembly, represented by the link CRG, then:

$$F = q \sin\beta + p \sin\alpha$$
$$= \frac{PH}{L}$$
$$kP = p\cos\alpha - q\cos\beta$$
$$kPe = qf\cos\beta$$

Hence: $$q = \frac{kPe}{f\cos\beta}$$

$$p = \frac{kP}{\cos\alpha}\left(\frac{f+e}{f}\right)$$

Thus: $$F = \frac{PH}{L}$$

$$= \frac{kP}{f}\left[e\tan\beta + (f+e)\tan\alpha\right]$$

Hence: $$\tan\beta = \frac{Hf - kL(f+e)\tan\alpha}{kLe} \qquad (1)$$

The particular value of β obtained from this equation will

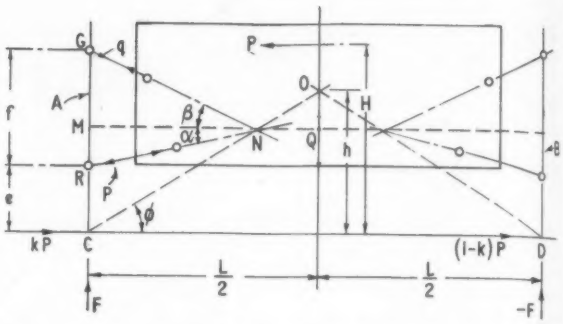


Fig. 3. In this illustration, the disposition of the suspension links has been arranged so as to make the diagram as clear as possible; however, the analysis that is given in this article is applicable to all possible arrangements, provided suitable angles α and β are chosen

give the desired force F without any movement of the stub axle relative to the body.

Consider next the position of the roll centre O. Then:

$$\lambda = \frac{L}{2}\tan\phi$$

But: $$\tan\phi = \frac{CM}{MN}$$
$$= \frac{e + NR\sin\alpha}{NR\cos\alpha}$$

Now: $$\frac{NR}{\cos\beta} = \frac{f}{\sin(\alpha+\beta)}$$

Therefore: $$\tan\phi = \frac{e\sin(\alpha+\beta) + f\cos\beta\sin\alpha}{f\cos\beta\cos\alpha}$$

Therefore: $$\lambda = \frac{L[e\sin(\alpha+\beta) + f\cos\beta\sin\alpha]}{2f\cos\beta\cos\alpha}$$

From equation (1):

$$H = \frac{kLe\tan\beta + kL(f+e)\tan\alpha}{f}$$
$$= \frac{kL[e\sin(\alpha+\beta) + f\cos\beta\sin\alpha]}{f\cos\beta\cos\alpha}$$

Thus, H is equal to h only if $k = \frac{1}{2}$, that is, only if the side force is shared equally by the road wheels.

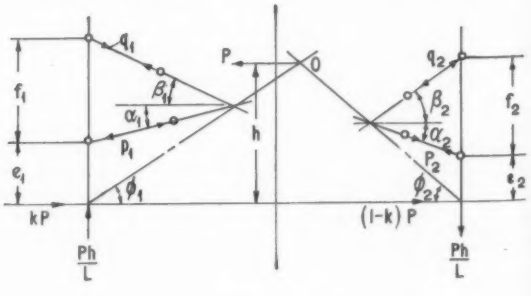
The conditions for no tilt of the body under the action of a side force are, therefore:

1. The force must act through the roll centre.
2. The horizontal wheel reactions must be equal.

Asymmetrical suspensions

In the foregoing analysis, it was tacitly assumed that the suspensions were the same at both sides, as will almost always be the case. However, when the results are applied to the transverse roll axis, this symmetrical arrangement will not usually apply, and it is therefore worth while to examine an asymmetrical system such as that illustrated in

Fig. 4. The asymmetrical system, which can be applied to a general analysis of conditions of roll about the transverse axis of the vehicle



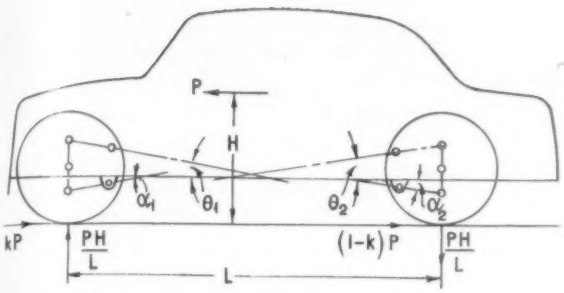


Fig. 5. This suspension system, by contrast with those illustrated in Fig. 1, is of the transversely-pivoted type. The analysis applied to determine the conditions of roll about the longitudinal axis can also be applied in this case, which represents roll about the transverse axis

Fig. 4. The roll centre is at O, and no longer in the central plane. In this system, as in the symmetrical one, the angles β_1 and β_2 can be chosen so that a side force P, acting at this centre and shared between the wheels in the proportions indicated, will produce no movements of the stub axles relative to the body, and therefore no tilt of the body. The angle β_1 will be given by equation (1), and the angle β_2 by a similar equation, with $(1-k)$ replacing k: in each equation, the quantities e, f and a must be given their appropriate suffixes. Again, if the ratio between the horizontal wheel reactions differs from the design value, then the force P acting through O will produce a tilt of the body.

Elimination of brake dive with independent suspensions

The suspensions illustrated in Fig. 1, at a, b, c and d, are examples of longitudinally-pivoted transverse link systems, whereas that illustrated in Fig. 5 is a transversely-pivoted link system. The similarity is apparent, and it should be clear that the analysis already applied to the longitudinal roll axis can be applied also to the transverse roll axis. Thus, by choosing the angles θ_1 and θ_2 appropriately, the inertia force couple PH due to braking can be balanced without any deflection of the suspensions relative to the body, and thus without any tilt or dive of the body. Again, this result will be obtained only so long as the ratio $k/(1-k)$, between the braking efforts, remains unchanged.

Dive may also be eliminated, with longitudinally-pivoted link suspensions, by suitably inclining the lever pivot axes as shown in Fig. 6. Since the body is going to tilt, there will be no changes in the spring forces, so these and the vertical reactions due to the weight of the vehicle can be left out of the analysis. The forces kP and $P(1-k)$ will produce forces q at the upper ball joints of the assemblies and, because the upper wishbones are free to rotate about their axes XX, it follows that the forces q must be parallel to those axes, otherwise the wishbones would not be in equilibrium. The couple PH produces forces $\pm F=PH/L$ at the wheels; and for equilibrium of the stub axles:

$$kPe=fq\cos\theta_1$$

and

$$F=\frac{PH}{L}$$

$$=q\sin\theta_1$$

Hence, for the one assembly:

$$\tan\theta_1=\frac{Hf}{kLe}$$

and, for the other:

$$\tan\theta_2=\frac{Hf}{(1-k)Le}$$

It can be shown that this result will apply whether the upper, the lower, or both wishbones transmit the spring forces from the body to the stub axle, and also that the no-dive condition can be satisfied if both wishbone axes are inclined to the horizontal.

At the rear of vehicles, independent suspensions are, however, used much less than at the front; and there is bound to be some restriction of the deflections at the rear, due to the couple PH and the consequent weight transfer PH/L, when conventional semi-elliptic springs are fitted there. If the independent suspension at the front is designed to accommodate the increase PH/L in vertical load, without any change in spring force, that is, by suitable choice of the angle θ_1, it follows that some dive will occur. However, if the front suspension is designed so that, under the action of the force kP, a decrease in spring force results and the body therefore moves upwards slightly, it might perhaps be arranged that the body will move upwards by equal amounts at the front and back so that no dive will occur. The conditions necessary for the attainment of this result will now be examined.

Elimination of dive with conventional rear suspension

Considering the vehicle as a whole, the additional forces due to braking are shown in Fig. 5. The change PH/L in the vertical reaction at the rear will cause the body to rise by an amount equal to PH/KL, where K is the rate of the rear suspension. If, therefore, the front suspension can be designed to produce, under the action of the forces kP and PH/L, an equal upward movement of the body at the front, then there would be no tilt of the body, that is, no dive.

To keep the algebra as simple as possible, it will be assumed that the lower arm of the front suspension is horizontal when there is no acceleration or retardation. Let C be the rate, reckoned at the wheel, of the front

Fig. 6. By suitable inclination of the pivot axes of the transverse links, as shown in this illustration, it is possible to eliminate nose dive under braking conditions

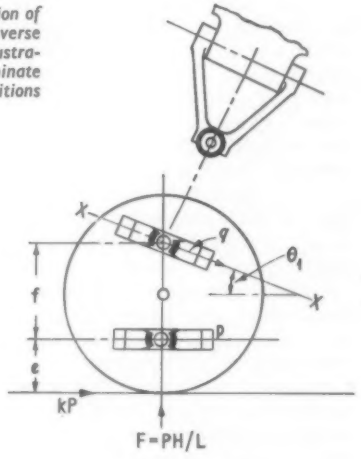
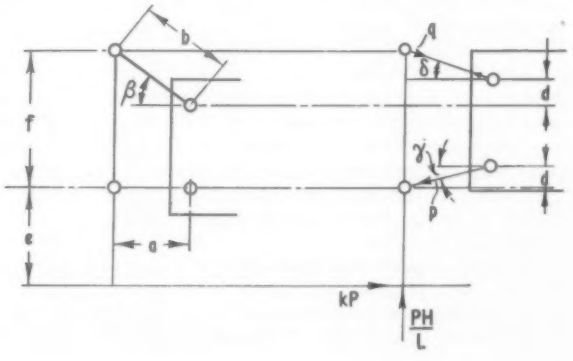


Fig. 7. For the purpose of the mathematical analysis, it is assumed that the lower arm of the front suspension is normally horizontal



suspension under static conditions, and let d be the deflection due to applied forces kP and PH/L. Then, referring to Fig. 7 and neglecting the tilt of the stub axle:

$$\sin \delta = \frac{b \sin \beta - d}{b} \qquad (2)$$

$$\sin \gamma = \frac{d}{a} \qquad (3)$$

$$\frac{PH}{L} = -Cd + q \sin \delta + p \sin \gamma$$

$$kP = p \cos \gamma - q \cos \delta$$

$$kPe = qf \cos \delta$$

Hence:

$$q = \frac{kPe}{f \cos \delta}$$

$$p = kP \tan \gamma \left(\frac{e+f}{f}\right)$$

and

$$\frac{PH}{L} = -Cd + \frac{kPe \tan \delta}{f} + kP \left(\frac{e+f}{f}\right) \tan \gamma$$

Substitute for tan γ and tan δ, from equations (2) and (3), and put $d = PH/KL$; then, after rearranging, the following equation is obtained:

$$\frac{KLb \sin \beta - PH}{\sqrt{K^2L^2b^2 - (KLb \sin \beta - PH)^2}} = \frac{f}{ke}\left[\frac{H}{L}\left(1 + \frac{C}{K}\right) - k\left(\frac{e+f}{f}\right)\frac{PH}{\sqrt{K^2L^2a^2 - P^2H^2}}\right]$$

It appears to be impossible to eliminate P from this equation, and it follows that β is a function of P. Hence, since β must in practice have a fixed value, it is not possible to eliminate dive except for one particular value of P, that is, for one particular value of the acceleration or retardation and for a constant value of k. For these particular values which can be chosen arbitrarily, the above equation reduces to a quadratic in $\sin \beta$, from which the value of β required to satisfy the equation may be obtained.

Automatic Machine Control

THE highly informative series of articles on American developments in automatic machine control is continued in the February 1958 issue of our associated journal *Aircraft Production* by a full description of a prototype digital control system, the Numill, fitted to a Cincinnati Hydro-Tel. With this system all contoured shapes are approximated by a series of straight-line chordal cuts. The information defining the cuts is contained as block numerical commands on magnetic tape. The relation of these commands to time, interpolation and the production of continuous-control information is carried in a control console attached to the machine tool.

Primarily, the system was developed for machining templates in the aircraft industry. Manufacture of templates and cam bars is essentially a two-dimensional problem, in which the cutter is set at a specific height and a contoured cut is taken in a plane normal to the cutter axis. The prototype Numill system operates in this manner and exercises continuous control over two-axis motions of the Cincinnati Hydro-Tel.

Certain decisions had to be made regarding the operational specification before design could be started. One was that the system should be capable of producing two-dimensional tools up to 15 ft in length by 56 in width. Another was that a general-purpose digital computer was to be used for the preparation of data. It was also required that the system should be applicable to drilling and scribing operations and that it should be possible to store data for many parts on one control tape.

Other requirements were that the system should be reliable, easy to operate by persons having only the minimum of skill, and should be capable of controlling the machining of any two-dimensional shape. A unique operational feature included in the system specification was that it should be possible to inform the operator, by a visual display, of all the non-automatic functions that would have to be performed before and during a manufacturing sequence. The system was to operate basically in a digital manner and each control pulse was to represent a linear displacement of 0·0005 in. The prototype system eventually constructed includes, in greater or lesser degree, all the functions outlined in the original specification.

Briefly, the operational sequence with the Numill system is that initially a programme engineer specifies the shape to be produced by quoting the co-ordinates of points spaced round the periphery of the part. This information is then transcribed on to a set of punched cards, which are used as the information-input medium to a general-purpose digital computer. The control data required to operate the machine tool is then derived within the computer and recorded on magnetic tape. A workpiece is correctly set on the machine table, the magnetic control-tape is fitted in the control console connected to the tool, the operation is initiated and work is then machined to the required shape completely automatically.

The prototype has been very successful, but the experience gained with it has suggested certain modifications. Because of the concise nature of the block information impressed on the magnetic tape, it is proposed to substitute an eight-row paper tape as the data-input medium to the machine tool control system. A photo-electric head, operating at 200 rows/sec will be used to read the paper tapes. Furthermore, in future the dimensional equivalent of one control-pulse is to be standardized at 0·0002 in.

Data is handled in an unusual manner in the Numill system. First, the minimum mathematical data are specified and then entered into a general-purpose computer that produces block information defining the individual chordal straight-line cuts needed for machining the part. Then, contrary to the general practice in the United States of America, this block of information is entered directly into the machine tool control system, where it is translated into continuous-control information, because the necessary interpolation circuits are included in the control system directly attached to the machine tool. With other systems this phase is normally carried out in a unit called a director, which is separate from the machine tool.

Several advantages are claimed for this system. One of the more important is that the length of the control tape is shortened considerably, since a continuous-control signal is not impressed on the tape but only block information defining the incremental motions required of each slide.

Processing the data in the general-purpose computer is not expensive, because the computer is used efficiently. When the output of a computer is recorded as a pulse-train directly on to magnetic tape as a continuous-control signal, the operation of the computer is often slowed down because it takes longer to record the answers in this form than to compute. Where figures are recorded in block form, however, the transcription of the information is much more rapid and the operation of the computer is not likely to be delayed because the answers are not recorded quickly enough.

New Plant and Tools

Recent Developments in Production Equipment

A SMALL copying lathe built by the Swiss firm Edouard Dubied et Cie, S.A. of Neuchatel, is believed to be the only machine of this type equipped with a steplessly variable gear and an automatic control system giving a constant cutting speed and a constant rate of feed. On a machine provided with a geometrically stepped range of spindle speeds it is frequently not possible to find the desired cutting speed even for a single diameter of the workpiece. Where the work has widely differing diameters the divergences from the theoretically correct cutting speeds are likely to be considerable. These divergences will exercise a detrimental effect on the surface finish of the work and also on the serviceable life of the tool.

In terms of output, the need to compromise on the cutting speed selected in order to machine different diameters will adversely affect the rate of production. A copying operation, machining four diameters ranging from 13 mm to 80 mm on a small, single-throw, overhung crankshaft, provides an example of interest. On a machine lacking the automatically variable control a spindle speed of 700 rev/min was chosen, giving cutting speeds of 601 ft/min on the largest diameter and 91 ft/min on the smallest diameter. Production per day, 8 hours at 80 per cent efficiency, was 154 pieces. With a machine equipped for constant speed and feed, a cutting speed of 585 ft/min was selected and the production per day, under the same conditions, was 222 pieces; an improvement of 44 per cent.

The Rapid 515 lathe has a centre height of $4\frac{3}{4}$ in and is manufactured in alternative bed lengths, admitting either $15\frac{3}{4}$ in or $25\frac{3}{4}$ in between centres. Rigid construction and spindle speeds up to 4,000 rev/min render it suitable for the use of hard-metal tools. As the metal removal at such high speeds is considerable, the machine is designed with a bed inclined to discharge the chips into a wheeled truck positioned at the rear. The spindle motor is rated at 7 h.p. and the maximum turning diameter is $5\frac{5}{32}$ in.

Either flat or round templates can be used and it is claimed that the convenience of the machine makes the preparation of a template an economical proposition for short runs of, say, one dozen pieces. The machine is not suitable for large diameter face copying. Spindle drive from the motor is through a clutch to the twin, sliding-flange, pulley type variable gear and thence by multiple vee-belts. Speed is regulated by a unit incorporating three potentiometers (relating to diameter, rotational speed of the spindle, and cutting speed) which controls the servo-motor actuating the variable gear. The complete range of spindle speeds up to 4,000 rev/min can be run through in four seconds.

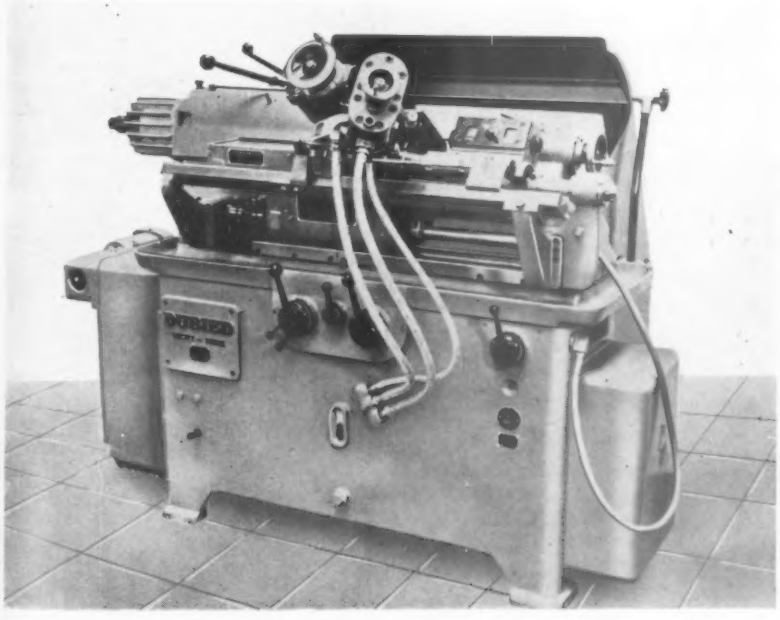
Once the initial cutting speed has been selected to suit the starting diameter of the workpiece and the type of material, all subsequent operation is completely automatic. Feed is applied by mechanical action from the hydraulic system, maintaining a constant rate per revolution of the spindle and ensuring uniformity of finish on all diameters.

Selling agents for this and other Dubied lathes are Wickman Ltd., Fletchamstead Highway, Coventry.

Arc-welding electrode holders

Two new electrode holders have recently been put into full-scale production by Lincoln Electric Co. Ltd., Welwyn Garden City, Herts. They are smaller versions of the Jackson A.3.S electrode holder, introduced some time ago from America. To be known as Lincoln-Jackson holders, the new models are designated A.W. and J.H.2.

Type A.W. has a length of $9\frac{3}{4}$ in and weighs only 14 oz. It will operate at up to 300 amp and is claimed to be one of



Dubied Rapid 515 copying lathe with automatically constant cutting speed and rate of feed. Two models are available, accepting $15\frac{3}{4}$ in and $25\frac{3}{4}$ in respectively between centres

Wickman Ltd.

Lincoln-Jackson electrode holders. Type J.H.2 above and type A.W. below
Lincoln Electric Co. Ltd.

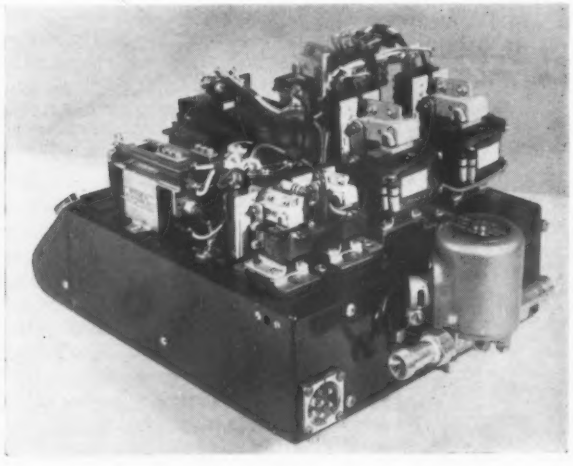
the lightest holders made that is capable of taking $\frac{1}{4}$ in diameter electrodes. The J.H.2 holder is rated to operate at up to 200 amp and to handle electrodes of $\frac{5}{32}$ in diameter. Since it is only 8 in long and weighs a mere $9\frac{1}{2}$ oz, it is recommended for work in difficult locations and for minimizing operator fatigue.

Both types have crown channel jaws of 98 per cent copper alloy and are thoroughly insulated, giving full protection from accidental arcing. For maximum heat resistance and durability, the jaws have glass-fibre reinforced plastics insulators and the handles are designed to provide good ventilation and operator comfort.

Spot-welding timer

A new electronic timer for gas-shielded spot-welding operations has been introduced by British Oxygen Gases Ltd., Spencer House, St. James's Place, London, S.W.1. It has been developed primarily for that Company's Argonarc spot-welding process, which is applicable to the 18/8 group of stainless steels and also to some of the newer high-tensile stainless steels, including FV520 and FSM1.

Electronic timer for Argonarc spot-welding process
British Oxygen Gases Ltd.



Previously, for these steels, a condenser relay timer was used to time the duration of the weld and an electro-mechanical process timer was employed to control the flow of argon used to cool the weld and to prevent surface cratering and cracking of the fused zone. On the new unit, however, both timing cycles are determined by a single electronic valve. The circuit can now be more readily serviced and the unit, normally mounted on the spot-welding cabinet, is smaller and lighter than the earlier version.

"Free-end" hose coupling

A failure in the flexible hose of a compressed air system may hold up production for as long as 15 minutes while a repair is being effected and the expense of maintaining pressure in a system having leaking joints is substantial. Under certain conditions escaping air may be a source of danger. These hazards are largely eliminated by the use of the "Free-end" nylon coupling manufactured by Airtech Ltd. of Haddenham, Bucks.

The coupling is produced in two forms. Type D is intended for joining together two lengths of hose, either of rubber or plastics. The free end of a length of hose is inserted into each end of the coupling and the two nut elements of the coupling are then screwed up by hand until the two hoses are securely locked. By this screwing operation

"Free-end" hose coupling. Single and double units in nylon and (centre) brass coupling for pressures exceeding 250 lb/in²
Airtech Ltd.

each hose end is gripped over a socketed internal spool by a toroidal spring, of steel, which is contracted in the conical bore of the compression nut. In the Type S coupling one end accepts the free end of a hose while the other end is screw-threaded for attachment to a shop line or other supply source, where it can remain permanently. The hose is secured by inserting it into the end of the coupling and screwing up the nut by hand, and it is readily detachable by a reverse procedure.

In nylon, the coupling is suitable for working pressures up to 250 lb/in². It is assembled into a single unit and need never be dismantled; no preparation of the hose is necessary; there are no loose bolts, nuts, clips, screws or ferrules; and no tools of any description are required. Its weight is exceptionally light; a joint can be effected in about 10 seconds; the hose can be secured or detached as frequently as required; and, for a specific bore, hose of differing wall thicknesses can be accepted.

Additional to its application in compressed air systems, the coupling is also suitable for water, petroleum, and chemical installations. For pressures in excess of 250 lb/in² a range of these couplings in brass will shortly be available.

BISRA lamination detector

Such defects in the ingot as piping, blow-holes, or segregation are likely to give rise to the formation of laminations in sheet metal. During the rolling process these flaws become flattened and elongated and result in discontinuities ranging from a fraction of an inch to several inches in width, running parallel to the surface of the sheet and usually invisible on the surface. They are a potential source of danger as, particularly during deep-drawing and pressing operations, they may cause the sheet to burst in the press, damage dies and tools, and thus disrupt production.

The British Iron and Steel Research Association (BISRA) has developed a simple detector for the examination of cold-rolled sheet steel for such flaws. In principle, the instrument applies a small electric current through the metal sheet, the difference in potential being measured with a millivoltmeter. The presence of any discontinuity in the path of the current causes it to flow round the interruption instead of directly between the two contact points, and the consequent change in potential is registered on the millivoltmeter.

Manufactured by the Ultrasonoscope Co. (London) Ltd., Sudbourne Road, London, S.W.2, the instrument, known as the BISRA lamination detector, is sensitive in operation while being robustly constructed for use in the shop by unskilled labour. It consists of two pairs of contacts mounted on Duralumin tongs, with a thin insulating strip between the current-carrying and the potential-measuring points. The millivoltmeter is mounted on the tongs for the convenient reading of potential and the contact points are smoothly rounded to prevent scratching of the sheet. All equipment, including either a 12V battery or a mains transformer, is mounted on a castor-wheeled trolley for portability.

On cold-rolled steel sheet laminations of a width of $\frac{1}{4}$ in and above are reliably indicated and even narrower defects can frequently be detected. The method, however, is not so dependable in the case of hot-rolled sheet. The instrument has also been used to check the soundness of the bonding on bi-metallic sheet.

The BISRA sheet metal lamination detector
Ultrasonoscope Co. (London) Ltd.

Flow-test instrument for oxy-acetylene blowpipes
British Oxygen Gases, Ltd. (Equipment Division)

Test equipment for oxy-acetylene blowpipes

It has been a common practice to flame test oxy-acetylene blowpipes, used for hand welding and cutting operations, away from the production line. Each blowpipe had to be coupled to both an oxygen and an acetylene supply, lit up, and then adjusted to check flame shape in order to ascertain that gas passages were unimpeded and that control valves functioned satisfactorily. This was a time-consuming procedure and was detrimental to good work flow.

A flow-test cabinet that can be sited conveniently adjacent to a production line, or an assembly line, has recently been designed and developed by British Oxygen Gases Ltd. (Equipment Division), Angel Road, Edmonton, London, N.18. On this instrument any defect in the operational efficiency of a blowpipe is readily detected by ascertaining whether the rate of air flow through the assembly conforms to predetermined specific tolerances. On the sloping work table quick-release type fixtures for the equipment to be tested are permanently mounted, and air can be supplied to these at the required working pressures by means of two rotary selector valves. Both high-pressure and low-pressure air systems are incorporated and pressure values in each are indicated on large dial gauges. An additional, smaller, gauge indicates the pressure of the air supply for dusting lines. Air flowing through the assembly under test travels by way of an expansion chamber into a Rotameter, from which the precise rate of flow can be observed. The three Rotameters, mounted at eye level, are marked for "Acceptance" and "Rejection" tolerances.

It is stated that a recent installation of this test instrument on a production line resulted in an output increase per man/hour of 30 per cent.

Crankshaft Heat-Treatment

Equipment by The Incandescent Heat Company Ltd. for The Scottish Stamping and Engineering Co. Ltd.

In consequence of an increasing need for expansion of the existing heat treatment facilities and also to integrate the heat treatment with a new crankshaft processing department, The Scottish Stamping and Engineering Co. Ltd., Neptune Works, Ayr, have recently installed mechanized continuous heat treatment furnaces designed and built by The Incandescent Heat Treatment Company Ltd., Cornwall Road, Smethwick, Birmingham. These furnaces are town-gas fired and have been developed for heavy service reliability, precision treatment and high thermal efficiency. They accommodate a wide range of forged steel crankshafts, and have a throughput of 750 shafts per day.

The inside dimensions of the hardening furnace are 43 ft 0 in long, 2 ft 6 in wide, 6 ft 0 in high, while the tempering furnace is 57 ft long, 2 ft 6 in wide and 6 ft high. There is longitudinal three zone control in the hardening furnace. The method of firing is a low-pressure multiple burner system for under and over firing, the heating gases being projected from the burner opening into the furnace chamber for circulation round the load. This arrangement gives even distribution by direct firing and radiation.

There are four separate zones in the tempering furnace. The first two zones are indirect fired by a multiple burner system similar to the system used in the hardening furnace. For the third and fourth zones firing is effected by separate gas recirculating units with single burners and high-velocity recirculating fans. In the tempering treatment, when radiation effects are negligible, the burner system provides turbulent convection currents, evenly distributed for precision treatment and accuracy of control.

Each zone in the two furnaces constitutes a separate firing system for the appropriate length, with independent gas supply, gas governor, back pressure valve and combustion air blowing fan with automatic temperature control. Waste gas extraction is effected through auxiliary and main exhaust outlets, positioned and graduated in conjunction with the chimney flue dampers to equalize furnace pressure conditions.

The furnace construction is unconventional in that the crankshafts are progressed through the furnaces in vertical formation in contrast to the more traditional method of horizontal progression on some form of moving hearth. The vertical suspension method provides ideal conditions for heating and soaking, and entirely eliminates the "hearth" effect that may be experienced in static and horizontal conveyor furnaces. Furthermore, maximum efficiency is obtained in quenching, since the shafts hang freely in the tank, completely separate from each other. Moreover, heat treatment distortion is greatly reduced.

Accurate temperature control is, of course, essential for satisfactory heat treatment. In these furnaces the independently controlled firing zones give an accuracy of $\pm$ 5 deg C in the hardening furnace heating and soaking zones and in the heating zones of the tempering furnace. In the tempering furnace, for the final soaking zones, which have a recirculating atmosphere, the working accuracy is $\pm$ 2 deg C.

The furnaces are situated side by side and are served at each end by fully mechanized travelling manipulators, which are operated from built-in control cabins. Crankshaft forgings are suspended from heat-resisting hangers carried by refractory line bogies that run on rails along the top of the furnace. The forgings are securely held in position by alloy adaptor brackets, specially designed to take a wide range of varying diameter crankshaft end flanges. The brackets are attached to vertical suspension alloy tee bars for double-line progression. The tee bars are supported from the overhead

Left. Hanger assemblies loaded with crankshafts ready for pushing into the hardening furnace

Below. The hardening furnace from the discharge end

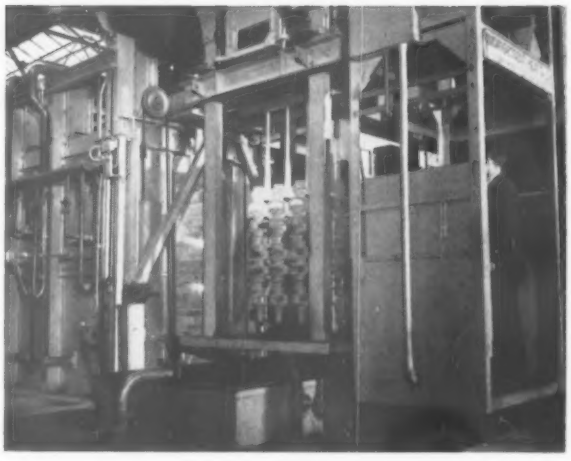
bogie carriages. These carriages are refractory-lined with continuous sand seals attached to each side. The supporting bars move through a single continuous slot in the furnace roof. Four hanger bars are attached to each bogie carriage to convey a load of eight suspended crankshafts; this constitutes a unit load for the heat treatment and quenching cycle.

Facilities are provided for quenching in either oil or water. In addition to the normal circulating pumps for cooling the quenching medium, each tank contains a series of high pressure jets through which the quenching medium, straight from the coolers, is directed immediately on to the individual forgings. This gives maximum agitation around the load of immersed crankshafts suspended in the tanks by the end manipulator quenching mechanism.

An automatic quench timer controls the quenching period and ensures that the forgings are raised from the quench with a given degree of residual heat to allow for partial stress relief prior to tempering. Normally, the timer is set for 15 minutes, but the quench time may be adjusted to accommodate variations in loading, crankshaft size and operation sequence.

The normal sequence of operations is as follows. First, a bogie load of heated crankshafts is extracted by manipulator from the discharge end of the hardening furnace and lowered rapidly into the appropriate quench tank, to be held there for the period pre-set on the quench timer. Following this, and at the other end of the unit, a bogie load of new forgings is pushed by manipulator into the charging end of the hardening furnace. The same manipulator then travels across to the discharge end of the tempering furnace and extracts a load of tempered shafts and carries them to a turntable for unloading. The manipulator is then reloaded and returned to the charging end of the hardening furnace. By this time, quenching has been completed at the other end of the hardening unit, and the load of quenched shafts is carried by manipulator to the charging end of the tempering furnace, where a previously quenched load is pushed in. To prevent the carry-over of excess oil or water into the tempering furnace, a draining period of two cycles is allowed between completion of quench and start of tempering.

On completion of the heat treatment cycle, the crankshafts are transferred hot from the furnace line on to a system of monorail conveyors, on which they are carried to a hot straightening bay. Each shaft is checked, and if necessary is straightened to remove any residual forge or heat treatment distortion. Following this, the shafts are transferred to a powered monorail cooling bank. The speed of this monorail can be altered to suit the rate of cooling for the particular shafts involved.



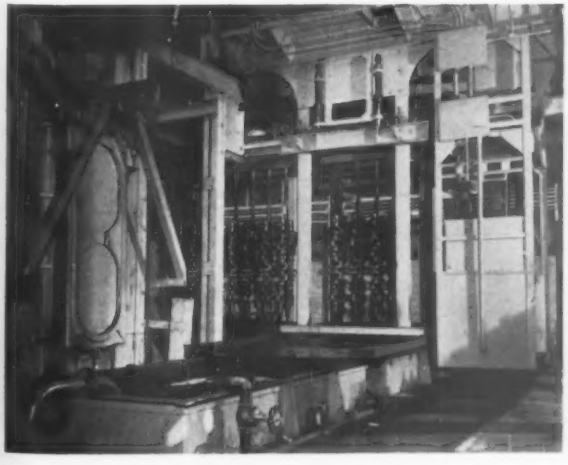
Loads drawn from the hardening furnace ready for quenching

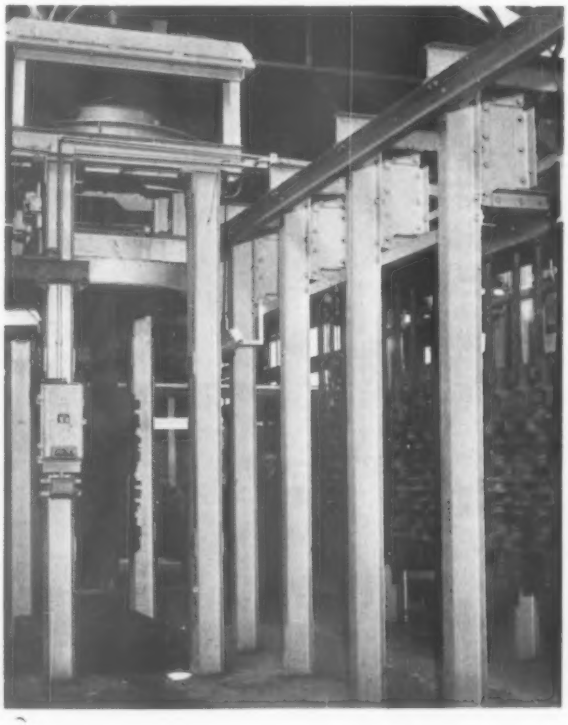
On reaching the end of the cooling bank, the now cold shafts pass through a Brinell hardness inspection bay and then continue by monorail to a shot blast descaling unit. Thence the shafts pass into a surface inspection section, which includes a modern magnetic crack detector and demagnetizer. Accepted shafts are then transferred by monorail to a final bay for dimensional checking and, if necessary, for centring and facing the ends.

This installation has now been in use for sufficient time to have proved itself. The Scottish Stamping and Engineering Co. Ltd. report that improved mechanical properties and more uniform hardness values have been obtained. In addition, users of the crankshafts have reported definite improvements in machining characteristics.

Right. The turntable used for loading shafts for heat treatment and for unloading shafts after hardening and tempering

Below. Hardened and quenched shafts being loaded into the tempering furnace





Manufacturing Small Diesel Engines

New Flow Lines and Transfer Machines for the Production of Major Components of the Perkins P3/144 Three-Cylinder Unit

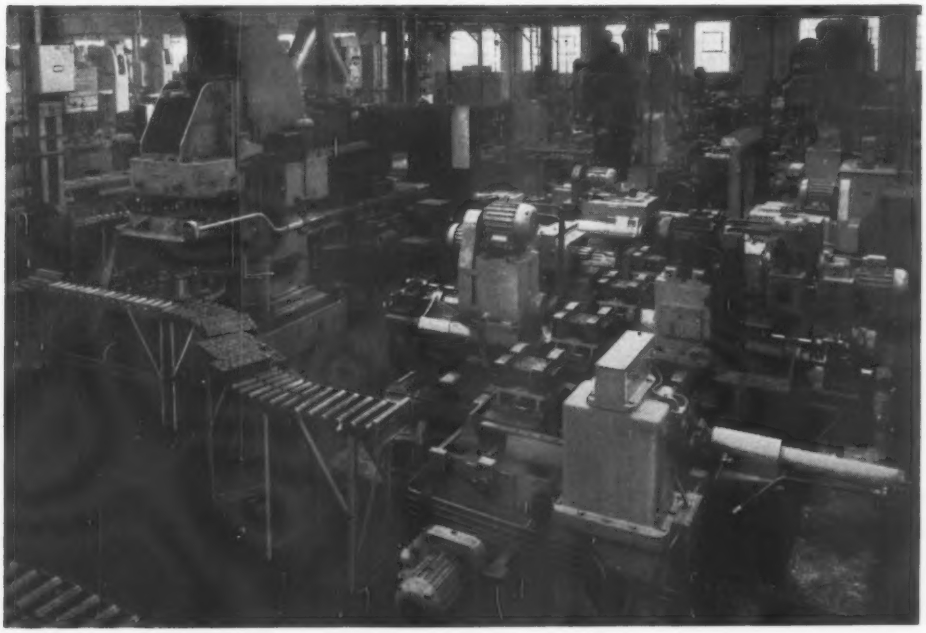
FOR several years an excellent example of standardization and the consequent type-reduction of components has been the Perkins range of three-, four- and six-cylinder diesel engines. Having common bore and stroke dimensions of 3½ in and 5 in respectively, such components as pistons, connecting rods, bearings, valves, valve gear, cylinder liners, and a multitude of smaller items are standardized for the entire range. This enables production, or purchase from outside suppliers, to be arranged at a high rate, tooling, stocks, and storage areas to be reduced, and spares organization and distribution to be simplified. All the engine units are adaptable, with minor modifications and special equipment, for a range of applications—transport, agricultural, industrial, marine and electric generating types are available.

Major components such as cylinder heads, cylinder blocks and crankshafts do not lend themselves readily to standardization measures if relatively light, small and compact engine units are required. Accordingly, production must be either batched, with a concomitant change of tooling between batches, or separately organized. Change of tooling involves the stoppage of machines and consequent loss of production. This may still present an overall economy so long as production requirements are well within the capacity available. Should it be necessary to raise the output, however, the tendency is to run larger batches in order to minimize the loss of production time absorbed in changing the tooling set-up. In turn, this entails the holding of larger stocks of machined components that embody considerable values of expended labour time. In such circumstances, a higher rate of utilization of production capacity may not yield the anticipated improvement in the overall economy.

Obviously, the heavy investment required for the provision of production equipment reserved for a specific component cannot be justified unless the equipment can be continuously operated at a reasonably high rate of efficiency. Nor would it be practical if the detachment of the particular component would result in an uneconomic lowering of the utilization rate of the existing equipment. Ideally, the production capacity made available by the detachment should be absorbed either by an increased output of the remaining components or by the introduction of new work.

It had long been realized by F. Perkins Ltd., of Peterborough, that the increasing adoption of the diesel engine in many different spheres was likely to result in demands for the various Perkins engines that would severely tax the firm's already extensive production capacity. The matter was continually under investigation and review. In particular, the rapid increase in the demand for the smallest Perkins engine, the P3/144 three-cylinder unit, was studied. It applied to all versions, but especially to those for agricultural machinery and for transport.

A decision was taken to install continuous flow-lines for the machining of the three basic components of this engine; the cylinder head, the cylinder block, and the crankshaft. Transfer machines, to be included in the cylinder head and cylinder block lines were to be of the Archdale platen type. Immediately difficulty was encountered as delivery of these machines would be unduly protracted. To cut the delay, Perkins designed and built the transfer machines with the active co-operation of James Archdale and Co. Ltd. Archdale experience was drawn upon, and Archdale basic components were used throughout.



First transfer machine on the cylinder head line. View from the loading end

All three production lines have recently been brought into full operation. The crankshaft requires the largest number of machining operations and this component is the determining factor in deciding on the output rate. Cylinder head and cylinder block lines were laid out and tooled to machine components at the rate of 250 units in 16 hours, that is, in two shifts. The crankshaft line was arranged for a production rate of 225 units in 16 hours. These figures represent production at approximately 80 per cent efficiency.

Characteristic features of the P3/144 engine are the patented "Aeroflow" combustion system and the high-level camshaft actuating the overhead valve rockers solely by mushroom-based tappets guided directly in the cylinder head casting. Timing is by gears throughout, taking the drive from the front end of the crankshaft. The gears are enclosed in a die-cast casing bolted up to a steel sandwich plate, secured to the face of the cylinder block. A gear-driven power take-off from the front end can be arranged for a hydraulic pump or other low-power auxiliary equipment requiring a torque not exceeding 25 lb-ft.

The combustion system is, in effect, a compromise between the swirl-chamber and the direct-injection types. A spherical chamber, formed half in the cylinder head casting and completed by a demountable hemispherical cap, communicates with the working cylinder by way of an inclined throat. The injector, with a two-hole nozzle, is mounted vertically and sprays one jet into the chamber while the other jet is directed down the throat towards the working cylinder. Fuel is injected at a pressure of 1,760 lb/in² (120 atmospheres). Decompressing gear can be provided, if required, to facilitate starting.

Main journal bearings and the big-end bearings of the H-section molybdenum steel connecting rods are of the replaceable, thin-wall, copper-lead lined type, and the small-end bush is also copper-lead lined. Big-end caps are each secured by two fitted bolts and self-locking nuts with nylon inserts.

Engines are differently rated to suit the various fields of application. The transport version develops 41 b.h.p. at 2,400 r.p.m. and has a maximum torque of 101 lb-ft.

Cylinder-head line

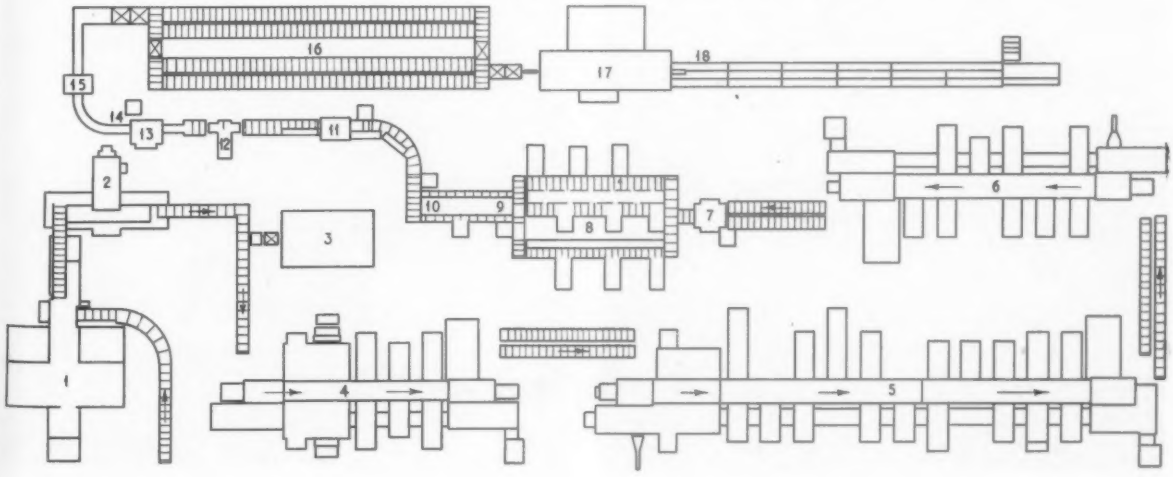
From the rough store, where they undergo a 100 per cent check on dimensions, profile, and core hole position, the cylinder head castings are transported by truck to the start of the line and stacked on the shop floor. Thence they are passed along a roller track to a Heller vertical, two-spindle miller, on which the top face of the head is finish machined and the joint face is roughed. The casting is loaded in a fixture and air clamped, and between stations is inverted so that it is finished in one pass. Galtona 10 in, shear type cutters running at 100 rev/min give a cutting speed of about 230 ft/min. On both faces of the casting, the depth of cut is $\frac{1}{16}$ in.

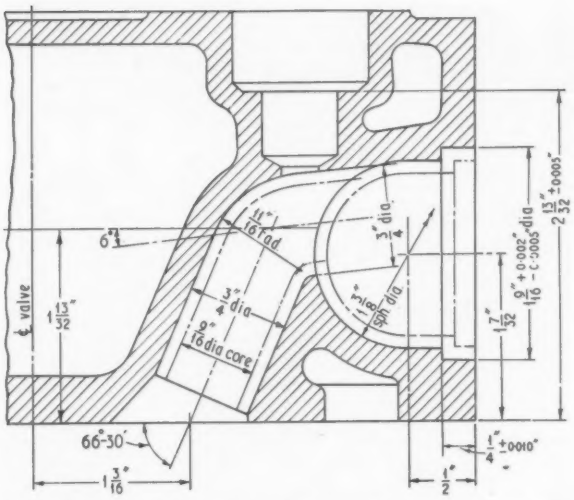
Archdale multiple-head drill with 3-station rotary indexing table

The head is then passed on a short roller track to a Cincinnati No. 3 vertical miller, where the joint face is finish skimmed at a feed rate of 20 in/min. The Galtona cutter takes a cut of 0·030 in approximately, the head thickness being held to 3·0±0·002 in. On an Archdale drill with a multiple head and a three-station, rotary indexing table, the casting is loaded joint face uppermost, and fifteen bolt holes and three tappet guides are drilled half-through and two jig location holes are drilled and reamed. After unloading, it is

Cylinder-head machining line

1 Heller vertical miller; 2 Cincinnati vertical miller; 3 Archdale drill; 4 first transfer machine, 6-station; 5 second transfer machine, 14-station; 6 third transfer machine 8-station; 7 fettling booth; 8 benches (blend combustion throats); 9 inspect machining; 10 fit studs and core plugs; 11 water test; 12 Mills hydraulic press; 13 Herbert drill; 14 mark valve and seat; 15 final inspection; 16 storage area; 17 Dawson washer; 18 blow out





Detail section of cylinder head, showing fully machined combustion chamber space and angled throat

returned to the roller track and passed to the start of the first transfer machine.

At station No. 1 it is manually loaded in a transverse fixture on the transfer platen, located on the dowels and secured by quick-acting clamps. Transferred to station No. 2, it is milled on both ends with Galtona 6 in cutters running at a cutting speed of 260-270 ft/min and a feed of 25 in/min. Travelling heads are employed on each side of the line. Each moves in to the work, takes its cut in the opposite direction to the other, moves out on its slide, and is returned to its starting position. Naturally, such a machine is of a length that cannot be accommodated in the standard pitching of the normal transfer units. Actually, it occupies the space usually provided for two stations and may give that misleading impression on the line layout diagram.

All holes in both ends of the casting are drilled at station No. 3, the holes are blown out and checked for depth at No. 4, and tapped at No. 5. Drills are operated at a cutting speed of 60 ft/min and at feeds of 3½-4 in/min. At station No. 6, the component is manually unloaded on to a duplicated buffer-storage roller track connecting with the second transfer machine. The platen, complete with fixture, is moved transversely by a hydraulic pusher to a lift, and lowered to the chain conveyor by which it is returned to the unloading end of the machine. Swarf is brought to the unloading end of the machine by a vibrating conveyor. The general hydraulic system for the machine functions at a pressure of 250 lb/in². Control is arranged at the loading end, the loader depressing a button to start the machine on its automatic time cycle. As a safety measure, the starting circuit is interrupted until both unloading and loading operations have been completed.

Both sides of the casting and also the top face are machined on the second transfer machine, which comprises fourteen stations. The component is loaded at No. 1 and both sides are milled at No. 2, as described on the first machine. At No. 3, seven holes are drilled and three injector recesses, $\frac{7}{8}$ in diameter, are drilled in the top face. On the exhaust side, three hemispherical combustion chamber spaces are rough machined. Six valve guide holes and three tappet guides are rough drilled at No. 4. Tappet guides are too closely pitched to permit simultaneous drilling of all six. Also at this station, three injector holes, $\frac{9}{16}$ in diameter, are drilled to depth.

At the next station, No. 5, fifteen bolt holes and three tappet guides are drilled to break through to those drilled earlier, on the Archdale indexing drill, from the joint face. Nine stud holes are drilled in the exhaust-side face. On the same side face, the three combustion chamber hemispherical spaces are finish machined and the combustion chamber recesses are roughed at station No. 6. These recesses are finished $1\frac{9}{16}{}^{+0\cdot002}_{-0\cdot0005}$ in diameter, and six stud holes are drilled in the same face at station No. 7. From the top-face three injector recesses are finish counterbored to $1\frac{1}{64}$ in diameter and three tappet guides are semi-finish reamed. The other three tappet guides are similarly reamed at the next station, No. 8, and three $\frac{9}{32}$ in diameter injector holes are through-drilled.

Except for the drilling of the ten stud holes in the intake-side face at No. 9, the operations at stations No. 9 and No. 10 are similar. At each, three valve guide holes are semi-finish reamed and three tappet guides are finish reamed to $\frac{5}{8}{}^{+0\cdot00075}_{-0\cdot0005}$ in diameter. The three remaining work stations are each tooled for the tapping of stud holes. At. No. 11 all holes on the top face and the two sides of the casting are blown out and checked for depth. Nine holes are tapped in the exhaust-side face and ten holes in the intake-side face at No. 12, and six holes in the top face at No. 13. From No.

Loading station of third transfer machine and three stations for core-drilling operations

Station 5 of third transfer machine, with tooling for roughing six valve seats

Herbert drilling machine set up for finishing valve seats with an annular tool piloted from the valve guide

Inspection of valve seats for concentricity, using a tapered pilot in the valve guide and a dial indicator

14 station, the component is unloaded on to another buffer track linking with the succeeding machine.

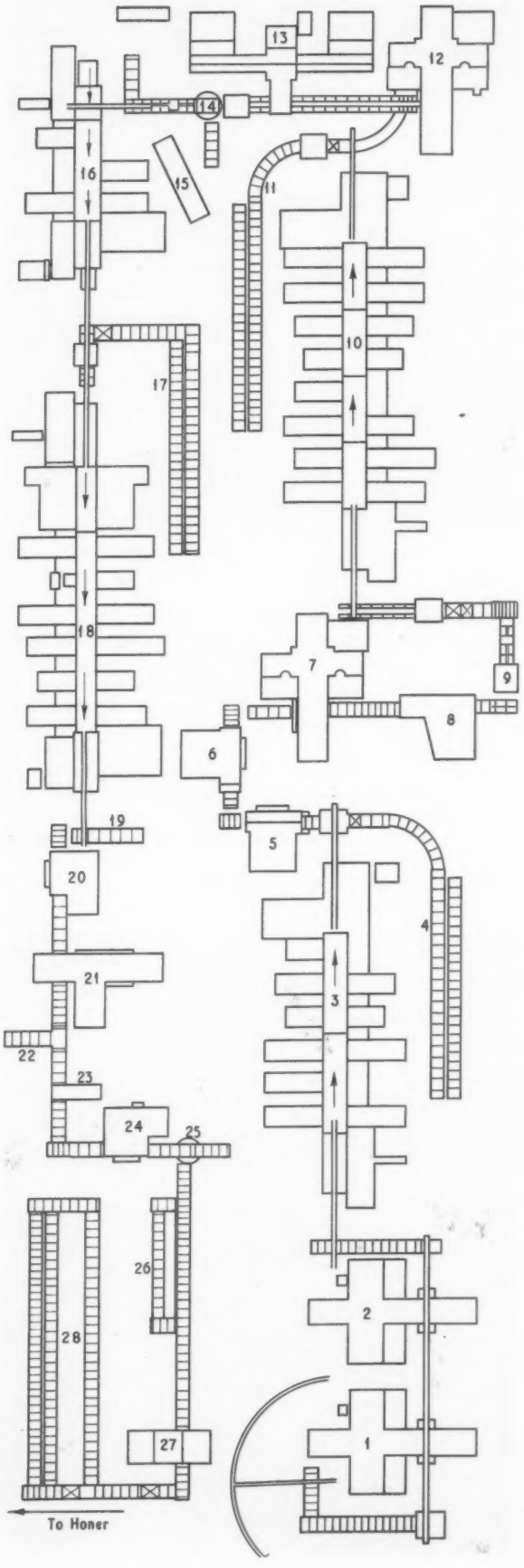
On the third transfer machine, the casting is inverted to bring the joint face uppermost and is clamped up to the platen fixture. The first operation, at station No. 2, is the core-drilling of three intake ports and three exhaust ports from the joint face, and three combustion chamber throats from the exhaust-side face. At No. 3, the three combustion chamber throats are core drilled from the joint face, and at No. 4 the throats are chamfered at an included angle of 40 deg from the joint face and are form-reamed from the exhaust-side face. Three intake valve and three exhaust valve seats are rough machined at station No. 5, leaving 0·010-0·015 in on the diameter for finishing. The head recesses for all valves are finish machined.

Combined tools are used at station No. 6, to finish ream six valve guide holes, to finish three intake and three exhaust valve ports, and to semi-finish three intake valve seats and three exhaust valve seats. From 0·005 to 0·010 in remains on the seats for finishing. At this station, also, a coned cutter is entered from the exhaust-side face to machine a small relief at the junction of the injector hole with the combustion chamber throat. The form-reaming of the combustion chamber throats from the joint face is the last operation, at station No. 7, and at No. 8 the casting is unloaded on to another buffer track.

At the end of the track is a fettling booth where the castings are dressed, sharp machining edges are frazed, and all holes and apertures are blown out. The form-reaming of the combustion chamber throats, from faces at right angles, at divergent angles in a common plane demands a precise location of the tools in precisely aligned and angled slides in order to attain a smooth blending of profile at the junction. After fettling, all castings are inspected for this feature and, where necessary, any minor rectification to obtain a perfectly smooth transition is effected by hand tools on a series of benches—marked 8 on the layout diagram.

At succeeding benches, the component undergoes a 100 per cent inspection of machining, and then all studs and screwed core plugs are fitted. It is passed along a roller track to a water test station, where it is mounted on a turn-over rig and subjected to an internal pressure of 35-40 lb/in². Next, the valve guides are pressed in individually on a Mills 8-ton hydraulic press. Meticulous care is taken to ensure the concentricity of valves and seats and accordingly the seats are finished with a cutter piloted from the bore of the valve guide. On a Herbert drill an annular cutter, that has been lapped on the pilot, is engaged over the pilot mounted in the valve guide and the valve seat is finish cut at an included angle of 88 deg. Depth of cut is checked manually with a dial indicator. Seats, ports and guides are blown out after this operation and the valves and seats are stamped with identification marks to ensure correct assembly. Seats are not lapped, as valves and seats are

Loading end of second transfer machine, for all operations on the front and rear ends of the cylinder block



finished to different angles—valves 90 deg and seats 88 deg.

During the final inspection, the depth of the seat to the joint face of the casting is checked (tolerance 0·010 in), and concentricity of the seat with the valve guide by means of a tapered pilot in the guide and a laterally arranged dial indicator (tolerance 0·002 in total reading).

Finished cylinder heads are parked in a roller-track storage area and are passed through a Dawson washer to receive a hot, alkaline spray before issue to the assembly lines.

Cylinder block line

In the rough store the castings are inspected, and two cored holes are drilled and reamed and one pad is machined for fixture location. Externally, the castings are sprayed with a coating of priming paint. From the store, they are trucked to the start of the machining line and stacked on the shop floor.

The first operation is to rough and finish machine both the sump and joint faces on one of a pair of Heller two-spindle vertical mills, this being carried out in two passes on the same machine. Galtona 16 in and 14 in cutters are used, taking a $\frac{5}{32}$ in cut at a feed rate of 21 in/min. On the joint face, 0·015 in is left for finishing.

After facing, the casting is passed on a roller truck and an air hoist to the first transfer machine, an eight-station unit. Here, it is loaded on its side in the platen fixture and located by the holes previously reamed in the rough store. As it is progressed through the six working stations, all holes in both the sump and joint faces are drilled, blown out, checked for depth, and tapped. These operations include the two jig location holes in the sump face, drilled $\frac{31}{64}$ in diameter × $\frac{11}{16}$ in deep and reamed $\frac{1}{2}{}^{+0\cdot001}_{-0\cdot000}$ in diameter × $\frac{1}{2}$ in deep. It is unloaded by an air hoist on to a roll-over fixture and then passed, joint face uppermost, to an Asquith six-spindle boring machine or to a buffer-storage roller track, where an inspection of the preceding operations is made.

On the first Asquith machine, the parent bores of two blocks are simultaneously rough machined. The blocks are located by the dowel holes and air clamped. Cuts are taken at 190 rev/min, feeding at 0·013 in/rev. Blocks are then transferred by roller track and a turntable to the second Asquith machine on which, with a similar set-up, the bores are semi-finished, at 328 rev/min and a feed of 0·007 in/rev. The end bores are skimmed $\frac{3}{4}$ in deep to fine finish ready for a steady function, referred to later, at two stations on the fourth transfer machine.

From the boring machine, the block is unloaded on to a turntable and passed to a Cincinnati duplex miller where the two end faces are rough machined at a feed rate of 15½ in/min. Thence it is moved by roller track to an Archdale plunge-type miller, where the main bearing cheeks are gang-milled, feeding at 2·6 in/min. It is again unloaded on to a turntable and is then, in a roll-over fixture, turned sump-face uppermost. On a bench, the bearing cups are fitted and stamped for identification on re-assembly. It is turned on a table and then inverted in a roll-over fixture to bring the joint-face uppermost. On a roller track, which is divided in order to clear the projecting bearing caps, it is passed to the second transfer machine on to which it is loaded by an air hoist.

This machine has eight working stations at which all holes in both ends of the block are drilled and tapped or core-

Cylinder-block machining line

1 *Heller duplex miller*; **2** *Heller duplex miller*; **3** *first transfer machine, 8-station*; **4** *buffer storage and inspection*; **5** *Asquith six-spindle borer*; **6** *Asquith six-spindle borer*; **7** *Cincinnati duplex miller*; **8** *Archdale plunge miller*; **9** *fit bearing caps*; **10** *second transfer machine, 10-station*; **11** *buffer storage and inspection*; **12** *Cincinnati duplex miller* **13** *Burr 2-way borer*; **14** *inspection*; **15** *remove bearing caps*; **16** *third transfer machine, 5-station*; **17** *buffer storage*; **18** *fourth transfer machine, 10-station*; **19** *inspection*; **20** *Heller six-spindle borer*; **21** *Heller six-spindle borer*; **22** *inspection*; **23** *Mills hydraulic press*; **24** *Heller six-spindle borer*; **25** *inspection*; **26** *deburr, fit studs*; **27** *water test*; **28** *stand-down track*

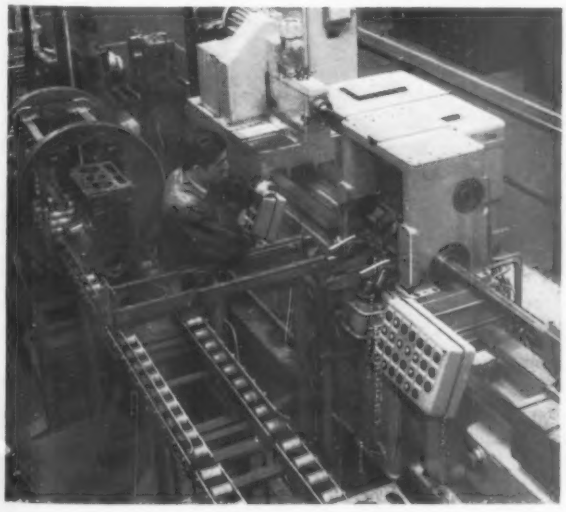
Unloading end of second transfer machine. Storage track on right and divided track on left of the roll-over fixture

drilled and reamed. Crankshaft and camshaft bores are core-drilled from both ends. At the unloading station, both the casting and the platen are vacuum cleaned by Dustmaster equipment, and the casting is unloaded by an air hoist to a divided roller track for a Cincinnati duplex miller, or to a roll-over fixture and on to a buffer storage truck.

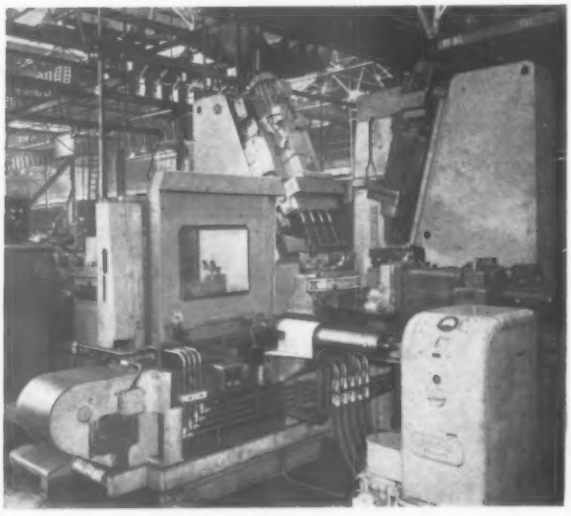
On the duplex miller, the end faces are finish machined to give the block an overall length of $14\frac{7}{16} \pm 0{\cdot}010$ in. The cut is taken at a rate of 18 in/min. Then on another divided roller track the block is passed to the Burr special double-ended boring machine, on which the crankshaft and camshaft bores are semi-finished and finished. Four crankshaft bores are held to 2·9175-2·9165 in diameter and taper must not exceed 0·0003 in or ovality 0·0005 in in any single bore. The three stepped bearings for the camshaft are each limited $^{+0{\cdot}002}_{-0{\cdot}001}$ in on their respective diameters. Two thrust washer facings are also machined on the rear crankshaft bearing by means of retractable bits in the crankshaft boring bar. The boring bits are automatically positioned radially on retraction to permit withdrawal through the key-slotted tool bushings. As will be seen in the illustration, the machine can be controlled by push button from either side of the loading position. The bores are then inspected on the track for dimensions, position, parallelism and squareness with the rear face of the block.

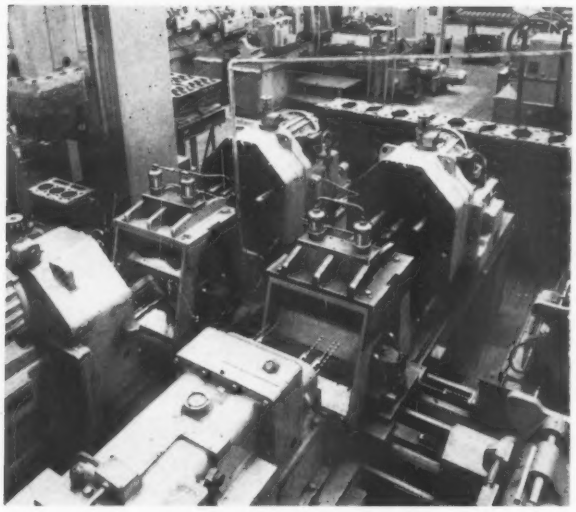
When the bearing caps have been removed, the block is loaded, sump uppermost, on the third transfer machine. At the three working stations, the crankshaft bearing-seat keeper slots are gang-milled, crankcase wall and partition ribs are skimmed to 3 in radius from shaft centre to ensure clearance for the connecting rod big-ends, and four oil holes are drilled from the bearing seats to the oil gallery. The casting is then unloaded by air hoist on to a roll-over fixture, where it is inverted and delivered, joint face uppermost to the fourth transfer machine or to a buffer-storage track.

Burr 2-way boring machine for roughing and finishing crankshaft and camshaft bore. The control station is duplicated



Third transfer machine unloading station. At the last work station oil ducts from journals to gallery are drilled





View from rear of fourth transfer machine, showing fork stations equipped with air cylinder steadies

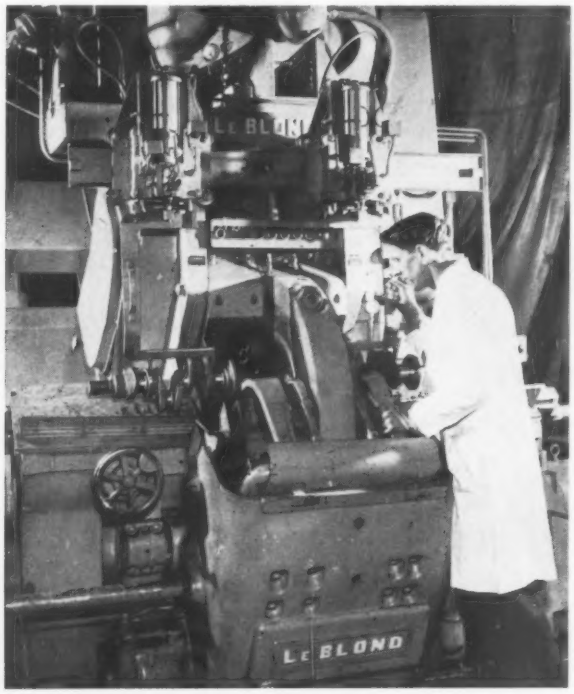
On this eight-station machine, both sides of the block are milled, drilled, and spot-faced, and core holes are opened out and reamed for plugs. At two stations on this machine, where the component is subjected to heavy lateral loading during spot-facing operations, automatically operated air steadies are provided on the fixture to hold the component firmly seated. The steadies engage in the end cylinder bores, mentioned earlier. After an inspection of the fourth transfer unit machining on the track, the blocks are loaded, two at a setting, on a Heller six-spindle borer and the parent bores are finish machined to $3\frac{11}{16}{}^{+0.000}_{-0.001}$ in diameter. These bores are held in the same plane and square with the bores of the crankshaft bearing housings to within 0·001 in.

Then, by roller track, the block is passed to a Heller vertical miller where the finish skim, of 0·015 in, is taken off the joint face. It is again inspected, this time for bore diameter, bore alignment, and block height, and then, on a Mills 30-ton hydraulic press, the cylinder liners are inserted individually. Next, on another Heller six-spindle borer, the bores of the liners of two blocks are finish machined in position. The finished bores are inspected and the block is passed on a roller track to a bench for deburring, checking clearances, and the fitting of core plugs. Further along the track it is clamped on a turn-over rig and undergoes a water test. Various zones of the casting are isolated and subjected to appropriate pressures—the water jacket at 25-30 lb/in², the oil pressure rail at 75 lb/in², and the cam chamber at a nominal pressure to prove oil-retention. The blocks are then "rested" for 16 hours in a large, roller-tracked storage area alongside, to allow for the settling of the cylinder liner bores.

Subsequently, they are transferred on the track to a Barnesdril Plugmatic honing machine (not shown on the layout diagram) for individual treatment of the liner bores. The machine has automatic indexing, and automatic sizing on the hone, and the bores are finished to $3\frac{1}{2}{}^{+0.002}_{-0.001}$ in diameter. After the bores have been inspected, the studs are fitted to the block, it is inverted in a roll-over fixture, and passed on to a roller track to a Dawson washer. Here it is given a hot alkaline spray and is then blown off ready for delivery to the assembly line.

This line provides an example of the flexibility of the organization. The functioning of a production line is continually under review; as an entity, in its various sections, and even to its individual machine tools. If at any point in a line the flow of work is impeded, slowed down, or interrupted; or merely if a better method or routine is suggested, the matter is thoroughly studied. If the case for a change is sustained, there is no reluctance or hesitation in

Le Blond centre-driven lathe, roughing main journals, shaft ends, cheeks, and flange

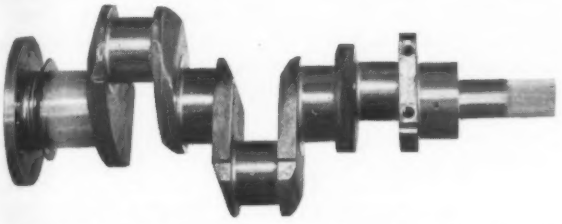


Landis grinder, roughing four main journals and the outer diameter of the flange

effecting rearrangement, modification, or replacement to obtain the desired smooth functioning.

In the short interval since the layout drawings and the photographs for this article were prepared, a modified sequence has been introduced in the latter part of the line. The honing of the cylinder liner bores is now accomplished in two stages, one before and one after "resting".

The Barnesdril Plugmatic machine has been brought into the line and located immediately after the Heller six-spindle machine on which the bores are finish machined. It is used to rough hone the bores, and the previously detailed sequence is then resumed. When the blocks have



The finished three-throw crankshaft. Shafts with end serrations are specifically for engines having a front power take-off

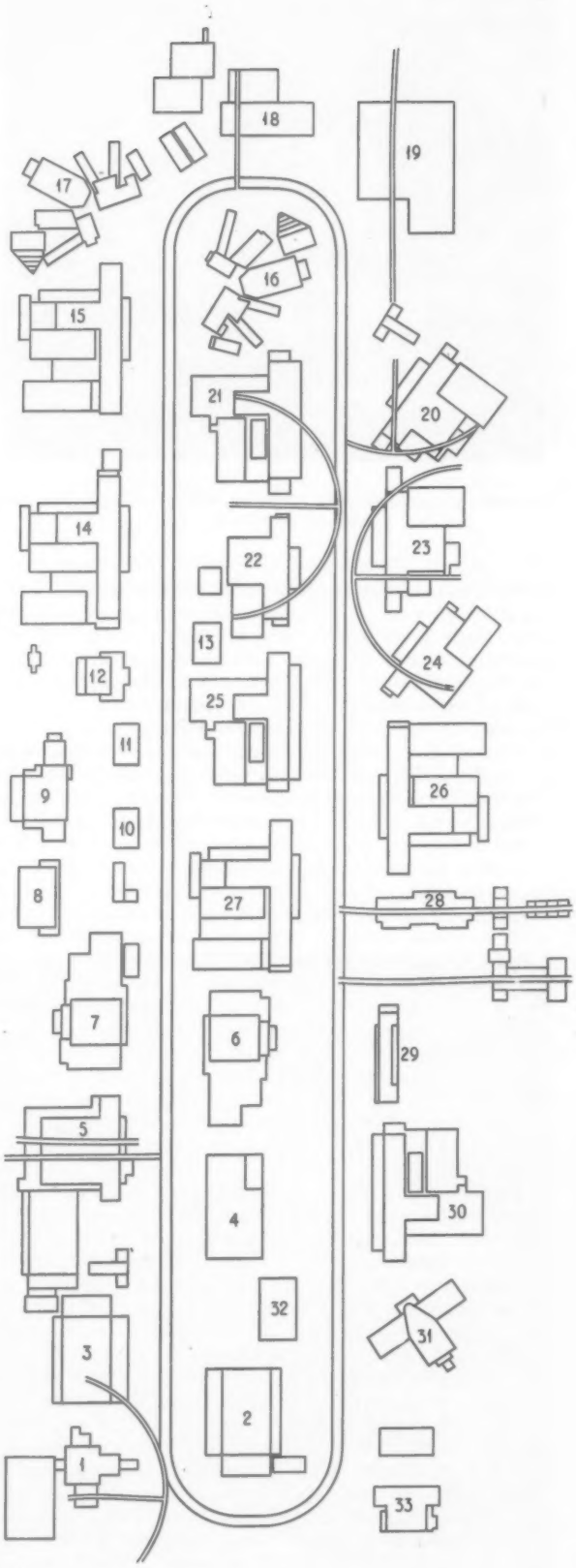
been "rested," however, they are transferred on the track to a Kitchen and Wade single-spindle hone for final honing to $3\frac{1}{2}{}^{+0.002}_{-0.001}$ in diameter. Thereafter, they are passed through the washer and are blown off, as before.

Crankshaft line

As received from the drop stampers, the chrome-molybdenum steel crankshaft with three throws at 120 deg and an integral flange for the flywheel, is ready centred. Before passing on to the machining line it is visually inspected and then checked on a fixture for depth of centre with a dial indicator. On first location the permissible tolerance is ±0·010 in. Plates hinged on the fixture check the web profiles and the machining allowance on the four journals and three crankpins. At the line the main transfer system is by a continuously running, looped overhead conveyor. Machine tools and benches are sited within and on each side of the conveyor loop and components are manually handled on and off the machines.

At the first station an Archdale five-spindle miller machines seven driving pads on the crank webs. This is preparatory for the next operation on a Le Blond 1 L.B. crankshaft lathe with central drive onto the two centre webs. The four journals, the shaft front end, the journal web cheeks, and the end flange are all rough turned and the oil-thrower ring is finish turned. This machine is duplicated in order to maintain the rate of production. The shaft is then checked and, if necessary, straightened to within 0·006 in and 0·008 in. on a Mills hydraulic press.

On a Drummond Maximatic the shaft is located from the flange-end centre and a multiple tool skims down the journal surfaces from their 0·008 in allowance to a 0·0025 in allowance in order to minimize wheel wear in the succeeding grinding operation. This is carried out on a Landis grinder with a gang of five wheels plunging to rough grind the four



Crankshaft machining line

1 *Archdale miller*; **2** *Le Blond lathe*; **3** *Le Blond lathe*; **4** *Drummond Maximatic lathe*; **5** *Landis grinder*; **6** *Le Blond lathe*; **7** *Le Blond lathe*; **8** *Pollard drill*; **9** *Cincinnati miller*; **10** *Pollard drill*; **11** *Pollard drill*; **12** *Pollard drill*; **13** *Pollard multiple tapper*; **14** *Newall H.A.C. grinder*; **15** *Newall H.A.C.grinder*; **16** *Archdale deep-hole drill*; **17** *Archdale deep-hole drill*; **18** *Efco induction hardening machine*; **19** *tempering furnace*; **20** *Precimax grinder*; **21** *Newall L.A. grinder*; **22** *Precimax grinder*; **23** *Precimax grinder*; **24** *Precimax grinder*; **25** *Newall L.A. grinder*; **26** *Newall H.A.C. grinder*; **27** *Newall H.A.C. grinder*; **28** *O.K. crack detector*; **29** *Trojan oil-grooving machine*; **30** *Newall L.A. grinder*; **31** *Archdale miller*; **32** *Churchill-Cleveland hobber*; **33** *Perkins tape lapping machine*

Archdale special, angled-head, deep-hole drilling machines for drilling oil ducts in the shaft

journals and the outside diameter of the rear flange. Next, the shaft goes to a Le Blond 6 A.C. two-station, crankpin lathe where it is located, clamped and driven on the end journals and end web pads. At the upper station the webs are skimmed and the flashes on the crankpins and the corner radii are trimmed down. The crankpins are rough turned at the lower station. This machine, also is duplicated.

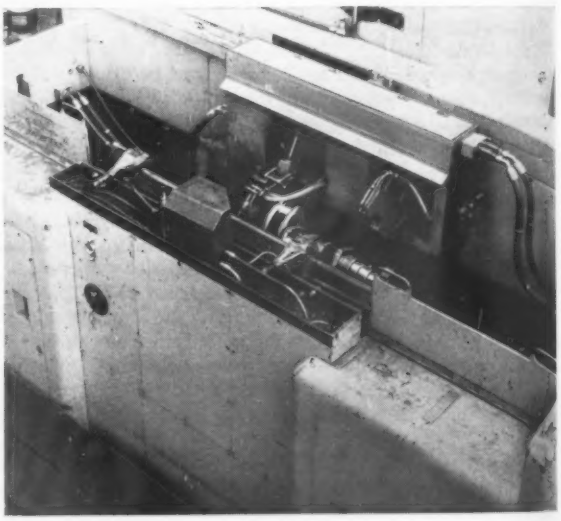
After again checking and straightening on a Mills hydraulic press, the shaft is then transferred to a Pollard two-spindle drill where it is radially located from the web pads. At one station five bolt holes and one location dowel hole are drilled in the rear flange, while at the second station one bolt hole is drilled, the dowel hole reamed, the central zone of the flange face relieved, and the centre re-cut. On the next machine, a Cincinnati Hydramatic rise-and-fall miller, the shaft is located from the dowel hole in the flange and the counter-weight registers are milled to height and width.

Various drilling and tapping operations follow, all on Pollard machines. The front end of the shaft is drilled, core-drilled, tapped and chamfered to receive the starter dog. One machine is a two-spindle unit built on a four-spindle base to accommodate a long table and traversing movement. Here the counterweight registers are drilled and tapped; the shaft being located by means of the flange dowel hole and an index plate. On the last machine the six holes in the flange are tapped.

Two Newall 48 H.A.C. grinders then rough grind the crankpins, leaving 0·012-0·014 in on the diameters. A total of six oil ducts, two to each crankpin, is drilled on two special Archdale angular, deep-hole drilling machines, each of which has three heads. After drilling, the holes are chamfered on the bench by means of an air drill and then frazed. Copper sleeves are then fitted over the shaft ends to dissipate heat during the next operation, when the journals are hardened on an Efco automatic 100 kW induction hardening machine. On an automatic cycle the cradle is moved from the loading station at the left-hand end of the machine to the work station. Here are mounted two inductors of the split-clamp type; one wide and one narrow. Sequentially, the work cradle is progressed to the right and the front-end journal is hardened by the wide inductor, the two intermediate journals by the narrow inductor and the rear-end journal by the wide inductor. In each instance the work is quenched by water spray immediately after heating. On completion, the work cradle is moved to the unloading station, is lowered to deliver the work on to a chain-type, discharging conveyor, continues down to a lower level, and is returned to the other end of the machine on a conveyor and elevated to the loading station. The crankshaft is tempered in an electric furnace and then given a reference check and, if necessary, is straightened on a Mills hydraulic press preparatory to finish grinding.

The first journal to be finished is No. 4, at the rear end. Mounted on centres on a Precimax grinder and located on a No. 4 journal cheek by a dial indicator, the journal is plunge ground to diameter, using an M.P.J. continuous grinding gauge, to a tolerance of 0·0005 in. The width of grind, determined by the wheel, is to a tolerance of 0·002 in and 0·0156 in tolerance is permitted on the corner radii. No. 3 and No. 2 journals are plunge ground on a Newall L.A. grinder and a Precimax grinder respectively to the same diametral tolerance, but with the width tolerance increased to 0·008 in.

A form wheel on a Precimax with the head angled at 30 deg is used to grind the outside diameter and the rear face of the flange—the flywheel register. The shaft is located endwise by a dial indicator and the wheel is plunged in at an angle. Flange diameter is held within a tolerance of 0·002 in by a "Stop-cut" automatic sizing device, manufactured by Electronic Gauges Ltd. Another Precimax grinder with an angled head finishes the No. 1 journal to the same tolerance

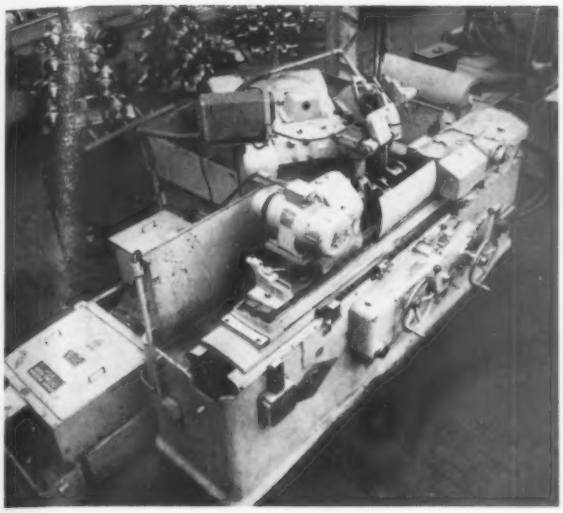


Efco automatically cycled machine for induction hardening of the four main journals

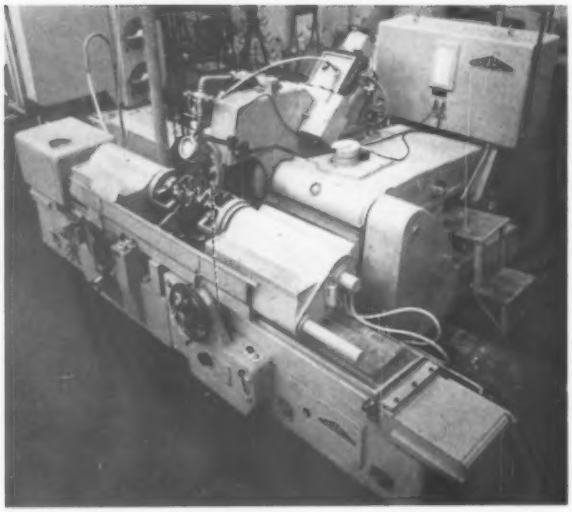
of 0·0005 in, the journal cheek face, and the shoulder for the timing gear. The diameter to receive the timing gear is then plunge ground on a Newall L.A. grinder, a tolerance of 0·0005 in being maintained.

Crankpins are finish ground to tolerances of 0·0005 in on diameter and 0·0015 in on width on a Newall H.A.C. grinder equipped with an overhead trimmer. The shaft is clamped hydraulically to the throw blocks; longitudinal location being arranged by spacing bars and radial location by an index plate. Automatic sizing is by Mercer electro-gauging equipment which stops the in-feed on reaching the specified dimension. Additionally, the size is indicated on a large dial. Scheduled dressing of the wheel is after five crankshafts—fifteen crankpins—have been finished. Only 0·002 in is required to be removed from the wheel.

Shafts are then given a 100 per cent inspection on an O.K. crack detector with semi-automatic rotation and head traverse. Both AC and DC methods are employed. A



Angled-head Precimax grinder, plunging a form wheel for the flange rear face and outer diameter



Newall H.A.C. grinder, finishing crankpins to a diametral tolerance of 0·0005 in. Mercer automatic sizing equipment is used

percentage check on journal hardness pattern is carried out by etching in a 10 per cent nitric acid solution.

The oil-return groove on the shaft between the thrower ring and the flange is turned on a Trojan (Selson) oil-grooving machine and the oil-return diameter is then finished on a Newall L.A. grinder. A keyway for the timing gear is cut on an Archdale miller. As there is a positional limit of 0·002 in for this keyway, location is from No. 1 crankpin. For engines requiring a power take-off from the front, the shaft end is machined with 48 serrations, extending 1·81 in to the run-out, on a Churchill-Cleveland Rigidhobber. Location is from the flange dowel hole. After washing off, all oil holes are given a 0·010 in radius with a hand tool. The last operation is to polish simultaneously all the journals and crankpins on a special, Perkins designed, tape polishing machine.

Every shaft is rigidly inspected before it is passed to the assembly lines. All dimensions are checked for conformity. Concentricity of the two intermediate journals with the outer journals has a tolerance not exceeding 0·001 in. Run-out of the flange face, the thrower ring face, and the thrust face has a permissible maximum of 0·001 in on a dial indicator. Crankpins and journals are allowed a tolerance of only 0·00025 in for ovality or taper and the surface finish, checked by Sigma Talysurf equipment, is held to a roughness value of 16 micro-inch.

General view of the two main assembly lines, on which the P3/144 engines are erected, at the Perkins factory at Eastfield, Peterborough

PRODUCTION RESEARCH

A Brief Survey of PERA Activities in 1957

SINCE its foundation rather more than ten years ago, the Production Engineering Research Association of Great Britain has year by year steadily extended the scope of its activities. This has, of course, called for an extension of the facilities for research and one important development during 1957 was the occupation of a new research block costing £250,000. In addition a new Education and Training Department was created during the year.

General investigations were carried out into impact (cold) extrusion of steel, deep drawing, automation, vibration, friction and lubrication, machine tools, finish blanking, cutting fluids, tool materials and other subjects. In addition, about 230 special problems and development projects were undertaken for individual member firms. These included performance of ceramic cutting tools, cold extrusion of aluminium and steel components, machining of stainless steel, Nimonic alloys and titanium, finish blanking of high tensile steels, vibration of machine tools and other production equipment, and grinding of cutting tools. Further, members requested technical assistance on most aspects of production, including works layout, finishing, mechanical handling, welding, work study, design for production and inspection.

Research

Cold extrusion. During 1957 considerable progress was made in investigations into impact (cold) extrusion of steel. Experiments have recently been started on the cold extrusion of large components, using a 1,000 ton press, which greatly extends the range of the Association's investigations into this highly efficient production process. Current research also includes investigations into the properties of steels for impact extrusion, variations in extrusion pressure with percentage reduction in area, and the conditions of lubrication required for backward extrusion.

Despite the tremendous possibilities of the cold extrusion process for reducing capital expenditure, floor space, handling, operation times, and material consumption for a wide range of products, application of the technique in Great Britain has been restricted by the lack of reliable data on tool design and on the extrusion properties of materials. Whereas very few British firms have taken advantage of the process, materials such as steel have been industrially extruded for about 20 years in Germany and approximately 10 years in the United States of America. However, development work which the Association is carrying out at present for various firms is expected to result in savings in the order of £40,000 per year in the production of one type of component alone.

Finish blanking. Research has continued into the PERA finish blanking technique, which produces pressings with smooth edges in contrast to the relatively rough edges produced by conventional blanking techniques. This technique frequently eliminates expensive shaving or machining operations in the production of pressings. It is being applied in a growing number of industries, including the manufacture of motor cars and of electrical goods. In one organization, a saving of £3,000 was effected in the production of the first component to which finish blanking was applied. Still wider application of the technique is expected when work on other materials is complete.

Deep drawing. Investigations have been continued to determine the relative efficiencies of a number of lubricants when deep drawing various materials. The results of these investigations are expected to provide a reliable basis for the

Part of the new Production Engineering Research Association workshops and laboratories at Melton Mowbray

The new metrology laboratory at Melton Mowbray is very fully equipped for extremely accurate measurements

comparison of a wide range of lubricants that, at present, are largely selected by trial and error. Continuation of the work in another deep drawing investigation has confirmed that depth of draw can be increased under conditions that differ markedly from conventional practice.

Metal cutting

Following research into the drilling of cast iron, investigations have been carried out to determine the most suitable drill point shapes for drilling various steels. Significant increases in drill life have been obtained with point shapes differing from those conventionally used in production workshops. Current metal cutting research includes an investigation on an automatic lathe, to compare the performances of three types of high-speed steel, when machining alloy steel. In the course of this work, the opportunity is being taken to investigate the relationship between tool wear and workpiece diameter. Research is also in progress to compare the performances of various cutting fluids and the effects of different methods of applying cutting fluids when machining high tensile nickel-chrome steel with carbide tools.

Hobbing. Progress has been made in the Association's survey of high-speed hobbing. An assessment is being made of the effect on hob life of such factors as the number of hob starts, helix angle, and the number of teeth in the gear. Studies are also being made of hob wear, and of the effects on hob life of slight variations in hob tooth formation.

Reaming. A previous investigation into the effect of reaming conditions on hole accuracy and surface finish showed that there are critical values of cutting speed and feed rate above which the accuracy and surface finish of reamed holes rapidly deteriorate. As these values are the limiting factors that prevent the use of higher cutting speeds and feed rates in cutting operations, it is considered important to determine whether improvements in performance could be achieved by changes in reamer shape. Research has, therefore, been carried out to determine the effects of reamer shape on accuracy and surface finish. Changes in rake and circular land width influenced hole surface finish, and the test results indicated that swarf jamming has an important influence on reamer performance. Other factors that were investigated included chamfer angle and flute length and the effect of built-up edge on accuracy and surface finish.

Ceramic tools. An investigation into the performances of a range of ceramic tools when turning alloy steel is almost complete. Comparative tests have been carried on cemented carbide tools, and performance was assessed on the basis of tool wear in roughing operations, and on workpiece surface finish and wear in finishing operations. The economic aspects of the use of ceramic tools have been explored by tests to determine the effects of various speed and feed combinations that give constant rates of metal removal.

Tool grinding. Field investigations into problems concerned with cutting tool performance have emphasized the need for improved tool grinding techniques and a greater degree of control. An investigation in which conventional and unorthodox methods of grinding carbide tools were studied, indicated that the speed and ease of grinding associated with a particular method were of considerable economic significance. The effect of the method of grinding on carbide tool life has also been investigated. Recommendations based on these results are being applied in industry, and economies in the form of reduced grinding wheel costs and longer tool life between regrinds have been reported.

Machine tools

A project concerning the accuracy and performance of several makes of cylindrical grinding machines was completed during 1957, while substantial progress has been made in an investigation into various aspects of machine tool slideways and their lubrication. A report is being prepared on the influence of scraped surfaces, lubricant viscosity, load per unit area, and sliding speed on the transition from boundary to hydrodynamic lubrication. Practical tests are also being carried out to determine the friction properties of various lubricants and machine tool slideway materials.

Vibration

It is not generally realized that the present limits of feed, speed, tool life, surface finish and accuracy are often set by

the vibration characteristics of machines and cutting tools. The difficulties caused by vibration are usually readily observed in operations such as boring and milling, but in apparently vibration-free operations the limitations on output and quality are, in fact, often imposed by minute, undetected vibrations. Full understanding of the nature and effects of these vibrations will help to remove the present barriers to substantial increases in the efficiency of existing techniques, facilitate the development of new techniques, and lead to the more efficient utilization of carbide and ceramic cutting tools.

By using experimental vibration-absorbers now being developed by PERA, excellent surface finish can be produced in some machining operations under conditions that otherwise would result in severe chatter, rough surfaces and, in extreme cases, tool breakage. Other investigations have indicated that the reduction or elimination of vibration often obviates the need for subsequent finishing operations such as reaming or grinding.

More and more makes and users of machine tools are coming to recognize the need for trained engineers who can interpret and apply the results of vibration research, and several member firms have seconded engineers to the Association for training periods lasting at least one year. These engineers receive instruction in the subjects necessary for complete understanding of vibration phenomena. They also assist PERA staff engaged in practical research into vibration. The course includes investigations into the vibratory characteristics of machine tool structures and elements and cutting tools, the correlation of theory and practice, and the analysis, interpretation and practical application of experimental results.

Automation

Because nearly all firms, large and small, will eventually be directly affected by the many developments now taking place in automation, an operational research is being carried out into a wide range of automation equipment. A report on hoppers and selector devices was recently issued to members. Subsequent reports will cover work-loading equipment such as magazines; mechanical hands; work-clamping equipment; work-conveying equipment; the application of various types of automation equipment in machining and presswork operations; and transfer machine tools and presses. To obtain direct experience of the problems involved in automation, and to expedite the PERA investigations, a number of member firms have seconded engineers from their staffs to the laboratories for periods of several months.

Education

Following the success of the 1956 courses for key personnel in industry, all the educational activities of the Association have been grouped into a new Education and Training Department, and permanent training facilities have been established in the former research laboratories. At the request of members, the general course on improved production techniques was repeated in 1957. The subjects covered by this course include metal forming, metal cutting, machine tool utilization, automation, method study and inspection.

The mobile unit visited approximately 140 factories in Scotland and the North of England. Nearly 11,000 key personnel at all levels in industry saw demonstrations, illustrated talks and films on improved production techniques developed by PERA. During 1958, the unit will gradually travel south through the Midlands and the rest of England, spending one to three days at members' factories. Further to assist members to make the most effective use of PERA research results and recommendations, approximately 800 visits were made during 1957 by PERA engineers to factories in all parts of Britain.

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DAF Hydro-Pneumatic Brake System

Arrangement and Operation of the Compressed Air Servo Control for the Hydraulic Brakes of Tractors and Trailers or Semi-Trailers

BEFORE the war, Van Doorne's Automobielfabriek N.V., of Eindhoven, Holland, manufactured their own air-actuated brakes. However, this aspect of vehicle design has become so specialized that in recent years their general practice has been to employ equipment supplied by brake manufacturers. The control system for the pneumatic-servo-operated hydraulic brakes on the DAF tractors and trailers or semi-trailer units is made up almost entirely of Westinghouse components.

Until 1956, many of the DAF trucks and tractors had hydraulically-controlled air-actuated brakes. With this system, the pedal actuated a hydraulic cylinder, which, in turn, regulated the degree of application of the pneumatic brakes. Now, however, the arrangement has been reversed, the air acting on a servo piston that operates the hydraulic master cylinder. This system is offered as an alternative to the vacuum-operated brakes, which are standard equipment for the DAF trucks. It is recommended for applications in which heavy-duty trailers are used.

The layout of the system is shown in an accompanying illustration. Air passes from the compressor to an oil separator, which prevents contamination of the system with lubricant from the compressor, and which also incorporates a tyre inflation valve. Next, the air passes through a pressure regulator valve into an anti-freeze device and thence into the first of the two main air reservoirs. An overflow valve is incorporated in the pipe connection between the first and the second main reservoir: it is so designed that air does not flow into the second reservoir until the first is fully charged, but the air can flow freely in the reverse direction. There are no other connections to or from this second reservoir.

The connection to the brake control valve on the towing vehicle, or tractor, is taken from the main reservoir. From this control valve, another pipeline leads to the rear, through a shut-off cock, to the coupling for the trailer system. A dual pressure gauge unit is connected to the pipe between the reservoir and the control valve, and to the line between the control valve and the trailer.

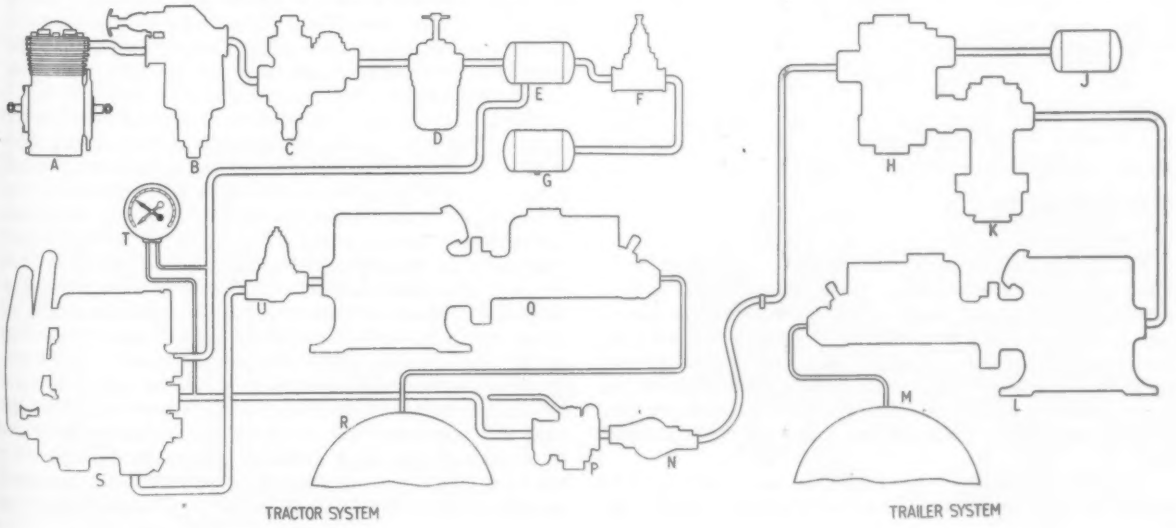
A third pipeline goes from the brake control valve to an advance valve, which ensures that the tractor brakes are applied a fraction of a second after those on the trailer, so that the danger of jack-knifing is avoided. From the advance valve, a connection is taken to the pneumatic servo of the tractor brakes. This servo operates a hydraulic master cylinder in the conventional manner, the hydraulic output being taken to the wheel brakes.

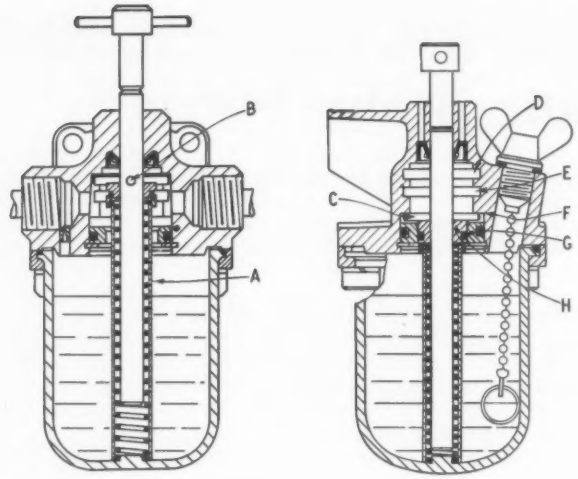
As has already been mentioned, a pipeline leads from the brake control valve to a coupling at the rear of the tractor. From this coupling, a hose is taken to the trailer, where it is connected to the trailer brake valve. This valve is so designed that the brakes are off when there is air pressure in the line from the tractor, but are applied when this pressure is released. This arrangement has the advantage that should the coupling between the tractor and trailer break, the brakes on the latter are automatically applied. The coupling is of the conventional type which, should the trailer and vehicle separate accidentally, rotates through 90 deg and is automatically disconnected.

Air pressure to actuate the pneumatic servo on the trailer is supplied from an air reservoir connected to the trailer brake valve. From this reservoir, the air goes through the trailer brake valve to an *empty-and-load* valve, and thence to the servo. The empty-and-load valve has a manually-operated control, which can be set to any one of four different

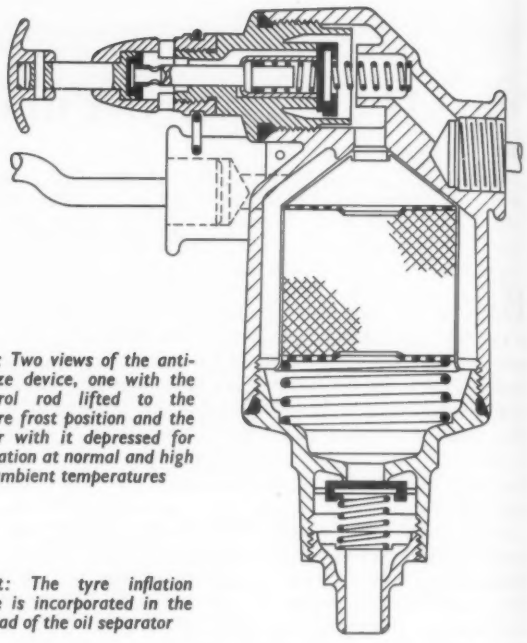
Layout of the DAF hydro-pneumatic brake system. The components for the tractor are grouped on the left and those for the trailer are on the right

A *compressor*; **B** *oil separator and tyre inflation valve*; **C** *pressure regulator valve*; **D** *anti-freeze device*; **E** *reservoir*; **F** *overflow valve*; **G** *second reservoir*; **H** *trailer brake valve*; **J** *trailer reservoir*; **K** *empty-and-load valve*; **L** *trailer brake servo*; **M** *trailer brakes*; **N** *hose coupling*; **P** *shut-off cock*; **Q** *tractor brake servo unit*; **R** *tractor brakes*; **S** *tractor brake control valve*; **T** *dual pressure gauge*; **U** *advance valve*

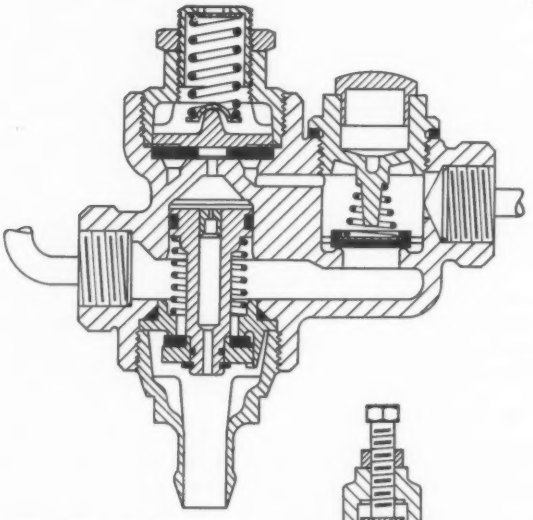




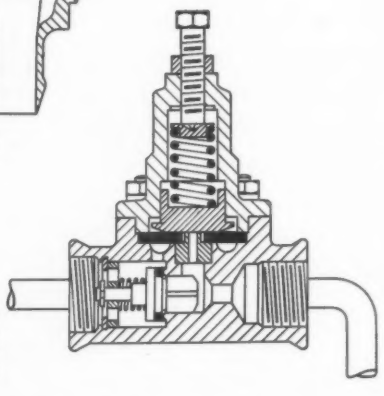
Left: Two views of the anti-freeze device, one with the control rod lifted to the severe frost position and the other with it depressed for operation at normal and high ambient temperatures



Right: The tyre inflation valve is incorporated in the head of the oil separator



Above: There are three valves in the air pressure regulator unit



Right: The overflow valve, which prevents air from passing to the second reservoir until the first is charged

positions. These positions are: full load, half-load, empty, and blow-off. The servo actuation of the trailer brakes is similar to that on the tractor.

COMPONENTS

Oil separator

The oil separator comprises an inverted bowl, closed at its lower end by a screwed-in cap. In the centre of this cap is a spring-loaded blow-off valve, which closes a port to atmosphere. Air enters at a connection in the side of the bowl and passes through a filter, to a port at the top, past the tyre inflation valve and thence to the outlet connection on the side opposite to the inlet. A coil spring underneath the filter pushes it up against a conical seat at the top of the inverted bowl.

To clear the oil out of the separator, the engine must be started and a push rod, housed in the tyre inflation valve cap, depressed manually. This pushes a valve on to its seating over the outlet port, so that the pressure of the air delivered from the engine-driven compressor rises in the separator until it blows the valve at the bottom of the unit off its seat and, at the same time, blows out any oil that may have collected in the well of the unit. This should be done, of course, at regular intervals and also immediately before the tyre inflator is used. The tyre inflation tube, of course, is screwed on to the valve after the cap has been removed.

Pressure regulator valve

The pressure regulator unit incorporates three valves. Air enters through the connection on the left—as shown in the accompanying diagram—passes the non-return valve, which is on the extreme right, and thence leaves the unit through the outlet connection adjacent to this valve. The chamber above the non-return valve is in communication with an annular space round the seat of the valve in the top of the unit. When the pressure in the system reaches a certain value, the latter valve is blown off its seat and the air pressure is communicated to a cylinder below. In this cylinder is a piston, which the air pressure forces downwards against a compression spring until it unseats the unloading valve in the base of the unit. This releases the output from the compressor directly to atmosphere. At the same time, the non-return valve on the right closes, so that the air pressure cannot flow back from the reservoir.

When the pressure in the reservoir falls to a predetermined level, the valve above the piston closes and the pressure in the cylinder is released through a bleed orifice and an axial hole in the centre of the piston, and thence down to the port to atmosphere. This allows the spring to force the piston upwards and reseat the unloading valve. When the upper valve is on its seat, a relatively high pressure is required to lift it, because this pressure acts only on the area exposed to the annular space. However, when the valve is lifted, its whole area is exposed to the air pressure, so the pressure has to fall considerably before it can seat again. Thus, the difference between the pressures at which the unloading valve comes into operation and is reseated is determined by the ratio of the projected area of the annular space to that of the whole area of the valve above it. The maximum pressure can be regulated by adjusting the compression in the spring that holds the valve down on its seat. This adjustment is

made by undoing the lock nut and rotating the thimble, in which the spring is housed, to screw it up or down, according to whether the pressure is required to be decreased or increased respectively.

Anti-freeze device

This device comprises simply a bowl of methyl alcohol with a cast aluminium alloy head closing its upper end. The air flows straight through a passage from one side of the head casting to the other. A three-position control is incorporated to regulate the rate of supply of methyl alcohol to the air stream. The three positions are for severe frost, light frost, and normal temperatures.

This control comprises simply a rod the lower end of which is surrounded by a coil spring with a cotton wick sleeve A wrapped round it. As can be seen from the accompanying illustration, there is a pin B in a hole drilled diametrically through the rod. This pin registers in one of the three slots, C, D, or E, and to move it from one slot to the other, the rod is turned through 90 deg, raised or lowered as necessary, and then turned back again. When the pin is in the uppermost slot, the maximum amount of wick is exposed to the air stream, and when it is in the lower position, the wick and alcohol chamber are isolated from the air flow, by the sealing ring G and its carrier H, which is mounted on the pin shank.

Overflow valve

The inlet and outlet connections on the overflow valve are on opposite sides of the casting, but a non-return valve is incorporated in the direct passage between the two. The function of this valve is to prevent air from flowing from the first reservoir into the second, but to allow flow to take place in the reverse direction. A passage from the downstream side of this non-return valve communicates with an annular space round the seating of a second valve, housed above.

A compression spring holds this valve on its seat, the load in the spring being adjusted so that the valve does not lift until the first reservoir is fully charged. When it lifts, it uncovers a port, through which the air passes to the upstream side of the non-return valve. There is no possibility of the overflow valve's fluttering, because when the valve is lifted, the whole of its area is exposed to the air pressure, whereas when it is on its seat only that portion of the valve that covers the annular space round the seat is subject to the air pressure. The spring pressure is adjusted by means of a screw and lock nut in the upper end of the thimble that houses the overflow valve.

Tractor brake control valve and the two advance valves

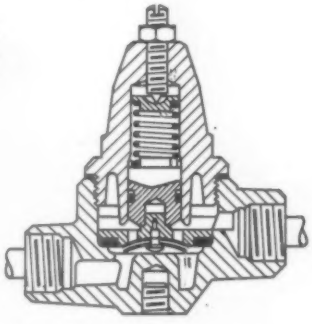
Both the foot brake and the hand brake controls are connected to the brake control valve on the tractor. As can be seen from the accompanying illustration, there are two actuating levers on this valve assembly. The left-hand one is connected to the foot brake control, and actuates both the tractor and trailer hydro-pneumatic brakes. On the other hand, the second lever is pinned to the hand brake control, which actuates the trailer hydro-pneumatic brakes, through the piston R, and which has a mechanical connection to the tractor brakes.

The chamber D is connected to the main air reservoirs, and there is a pressure balance duct between it and chamber H. When the brakes are not applied, chamber D is connected to the exhaust chamber G, through the open valve E and channel F. Under these conditions, air can flow under pressure from the main reservoirs through the valve E and the pipe line to the trailer brake valve and thence to the reservoir on the trailer.

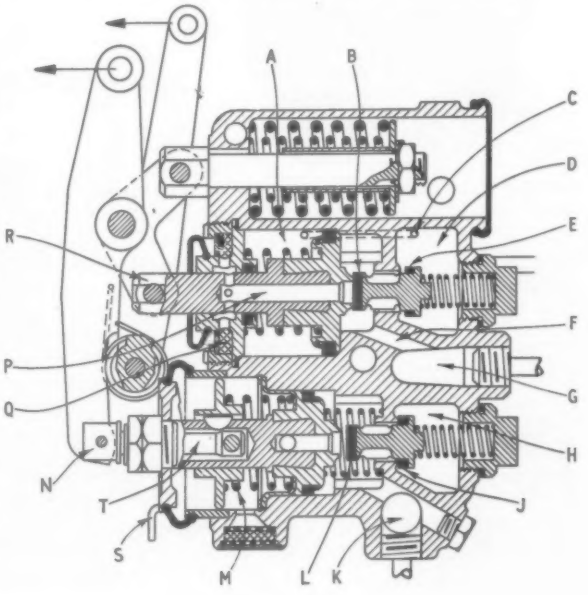
When the foot brake is applied, the actuating lever pulls the piston R to the left. This first allows valve E to close and then opens the valve B. The closure of valve E cuts off the air supply from the reservoir and the subsequent opening of valve B allows air to escape from the trailer brake line, through channel F, valve B, channel P and the filter Q, to atmosphere. There is a non-return valve in the connection to the reservoir on the trailer—this valve in fact is in the trailer brake valve assembly—so the air pressure cannot escape from this reservoir. The trailer brake valve is designed in such a way that the collapse of the pressure in the pipeline to it causes the trailer brakes to be applied by air from the reservoir on the trailer.

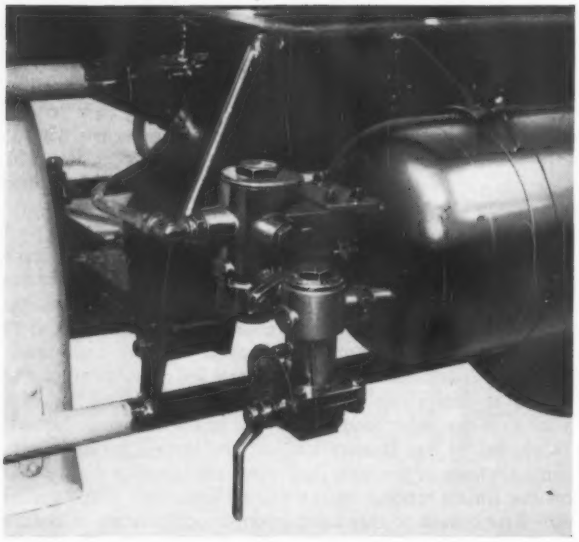
Movement of the lever that connects the foot brake control to the piston R also causes the piston N of the built-in advance valve to move. The length of the delay between operation of the pistons R and N is determined by the compression in the spring M, which can be adjusted only by the manufacturer. This adjustment is effected by movement of the lever S to rotate the disc to which it is attached. A cam formed on the inner face of the disc bears on two followers, not shown in the illustration, on the spring retainer cap. Thus, rotation of the cam disc alters the distance between it and the spring retainer cap, which is keyed on to the piston rod. The object of this adjustment is, of course, to ensure that the brakes of the trailer are applied before those of the tractor, so that the drawbar is in tension all the time and there is, therefore, no danger of jack-knifing. To ensure that the degree of advance braking is unaffected by differences in air

Right: The advance valve is incorporated in the system so that the trailer brakes are applied a fraction of a second before those of the tractor vehicle

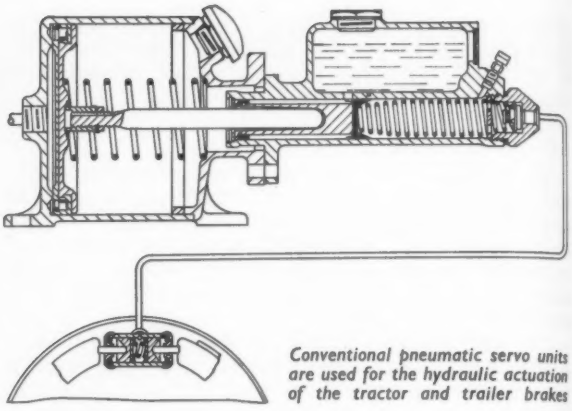


Below: Tractor brake control valve. The uppermost connection of those on the two levers is taken to the hand brake control, while the lower one is for the foot brake control. There are two main valve assemblies, the upper one being for the trailer system and the lower one, which is the main advance valve, serves the tractor hydro-pneumatic brake system





Installation of the trailer brake valve and empty-and-load valve, which are mounted together on the end of the air reservoir on the trailer chassis



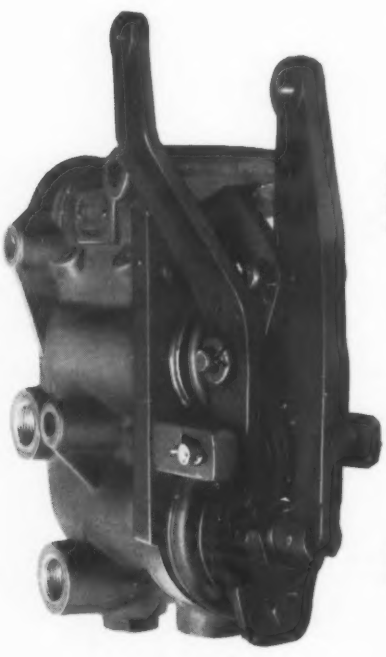
Conventional pneumatic servo units are used for the hydraulic actuation of the tractor and trailer brakes

pressure between chambers A and D, a small balance duct C interconnects these two chambers.

Movement of the piston N to the right closes the valve L and opens the valve J. This allows air from chamber H to flow past the valve J and through the connection K to the tractor brakes. From the connection K, the air goes to the second advance valve, which opens only after the pressure has reached a predetermined value. The degree of pressure required to open this valve can be regulated by the screw and lock nut, which, in the accompanying illustration, can be seen in the top of the valve housing. This valve is arranged so that, when the brake control is released, air can flow freely in the return direction from the brake servo.

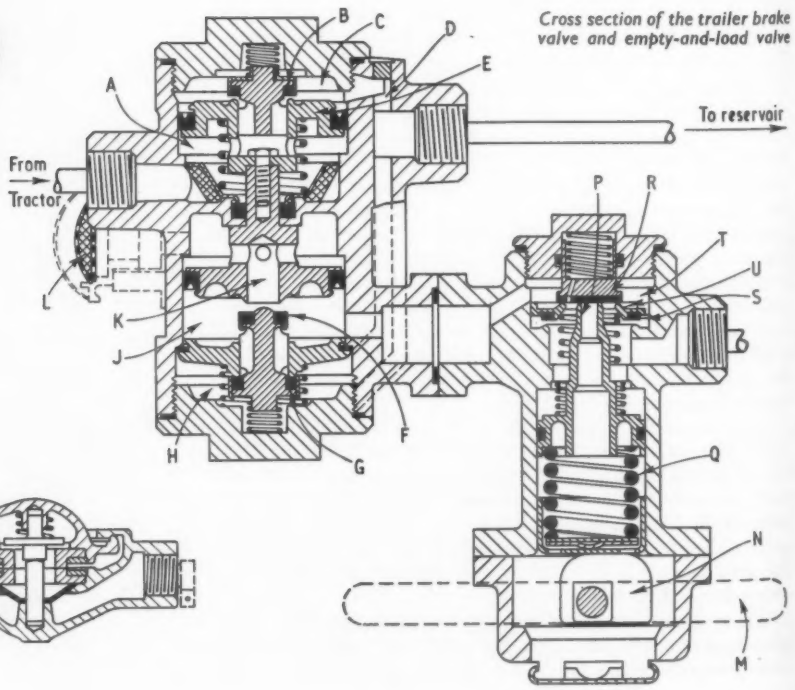
As can be seen from the cross section of the unit, the upper end of the rocker link that is pivoted on the foot brake control lever is pinned to a tie bolt tightened down against two concentric compression springs. These springs, which are housed in the uppermost chamber of the valve unit, are simply to prevent overloading of the mechanical connections to the valve unit in the event of excessive force being applied to the controls.

The brake servo operates in the conventional manner. Air pressure is supplied to a relatively large diameter piston,

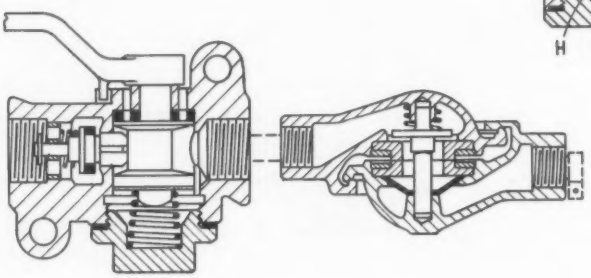


Left: The tractor brake control valve, a cross section of which is shown at the bottom of the previous page

Cross section of the trailer brake valve and empty-and-load valve



Below: The shut-off cock and breakaway coupling for the connection to the trailer



and the piston rod actuates a hydraulic master cylinder. When the air pressure is released, the piston is returned by a compression spring.

Shut-off cock and hose coupling to the trailer

As can be seen from the accompanying illustration, the handle of the shut-off cock actuates an eccentric spindle, which, in the on position, lifts a spring-loaded valve off its seat. In the off position, the valve is seated so that air cannot pass from the tractor to the trailer.

A conventional hose coupling of the rotary type is employed. It is arranged so that should the trailer break away from the tractor, the drag on the hose rotates the coupling and releases it automatically. When the coupling is connected, a push rod in its lower half lifts a valve off its seat in the upper half. Thus, when the coupling is broken, this valve is forced by its return spring on to its seat so that air cannot escape from the tractor system. At the same time, the fall in pressure in the trailer line causes the trailer brakes to be applied.

Trailer brake valve

In the accompanying illustration of the trailer brake valve, the connection on the left is from the tractor. Air passes through a filter into the chamber A. Thence it goes past the valve B into the chamber C and through the passage D to the outlet connection to the reservoir. When the pressure in the inlet collapses, the valve B closes and piston E is moved downwards under the pressure in chamber C. This closes the valve F and opens the valve G. Then air flows back from the reservoir and down, through an extension of the passage D, into the chamber H. From there, it goes into the chamber J and thence into the empty-and-load valve. When the pressure is restored in the pipeline from the tractor, the piston E is forced upwards, valve G is closed and valve F opened. Then the air flows back from the empty-and-load valve into the chamber J, through the passage K and the filter L and thus away to atmosphere.

Empty-and-load valve

The empty-and-load valve is mounted directly on the trailer brake valve. As has already been stated, it has a four-position handle M. This handle actuates a cam N, which adjusts the compression in the spring Q. In the full-load position, the hollow stem P is raised and lifts the valve R and the valve S. This allows the air to go directly to the brake servo. On the other hand, in the discharge position, the hollow stem P is lowered from the valve R, and then valve S seats. This allows air to escape from the brake cylinder, through the valve hollow stem P to atmosphere. In the other positions, when the brakes are applied, the pressure in the chamber T has to push down the seat U before it can flow through to the brake servo unit on the trailer chassis.

Bonding Plastics to Metal and Rubber

A NEED for a strong adhesive to join polyethylene directly to metal or to rubber has long existed. It is reported by the Franklin Institute, of Philadelphia, U.S.A., that the chemical research department of the Bell Telephone Laboratories has recently developed a simple bonding process that meets this requirement. It involves the use of partly hydrogenated polybutadiene, which is applied in a layer of from 0·002 in to 0·003 in thick. Various degrees of unsaturation of the polybutadiene, between 3 per cent and 30 per cent, will give satisfactory bonds.

The adhesive, known commercially as Hydropol, is manufactured by the Phillips Petroleum Co., of Bartlesville, Oklahoma, U.S.A. Other ingredients are added to the polybutadiene to render it capable of vulcanization. Metals should be brass-plated to secure an effective bond. The bonding agent may be made up in a solution and applied by spraying, brushing, or dipping. Alternatively it can be formed as a thin sheet which is inserted between the materials to be joined. Peel strengths up to 100 lb/in^2 and tensile strengths of 1,000 lb/in^2 are readily attainable. These values are claimed to be considerably higher than have been previously obtainable.

Significant applications envisaged are the lining of tanks, the covering of plating racks, the securing of insulation to electrical conductors, and the protecting of metals from corrosion.

Rubber Engineering

HITHERTO the reports of the Research Association of British Rubber Manufacturers have been issued exclusively to members of the Association and, six months later, brought to the notice of the rubber industry. This policy has now been relaxed and research reports, likely to be of interest to designers and users of rubber products, will be made generally available from time to time.

In view of the wide use of rubber anti-vibration mountings and the increasing application of rubber to suspension systems, this facility will be appreciated by the automobile industry. One of these reports, recently released, is No. 84, "Shape Factors and Functions in Rubber Engineering," by A. R. Payne. It is in three parts, dealing with rubber in compression, in shear, and in combined shear and compression.

The effective stiffness of a rubber component can be expressed as the product of three quantities; the elastic modulus of the rubber, the degree of compression, and a "shape function" depending solely on the geometrical configuration of the component. Hitherto the shape function has been represented by a confusing variety of arbitrary factors. The report, however, develops methods by which it can be calculated directly from the dimensions. This has been worked out for cylinders and rectangles used in compression, whether solid or centrally apertured, and with or without bonded ends, and for various forms of mountings used in shear or in a combination of hot shear and compression.

The data and methods given in the report present a simple and logical means of calculating the force/deformation relationships for most of the commonly used forms of component, given the one basic property of elastic modulus, either static or dynamic according to the type of deformation encountered in service. Copies of the report can be obtained, while present stocks last, from the Research Association of British Rubber Manufacturers, Shawbury, Shrewsbury, Shropshire. The price to non-members of the Association is one guinea.

Engine Testing

A New and Inexpensive Heenan and Froude Dynamometer

THERE are many instances where engines have to be tested for power over a range of speeds, but where the highest degree of accuracy in power measurement is unnecessary. The standard type of Froude hydraulic dynamometer, such as is used in the test shops of many motor car manufacturers, measures torque with an inaccuracy at full load of less than one-quarter of one per cent. Some users do not require such performance and find a lower standard acceptable, especially if the capital outlay is thereby substantially reduced. There are other instances where the actual power absorbed need not be measured, and all that is required is some means of imposing a controllable load against the unit on test so as to run it at various speeds and throttle openings.

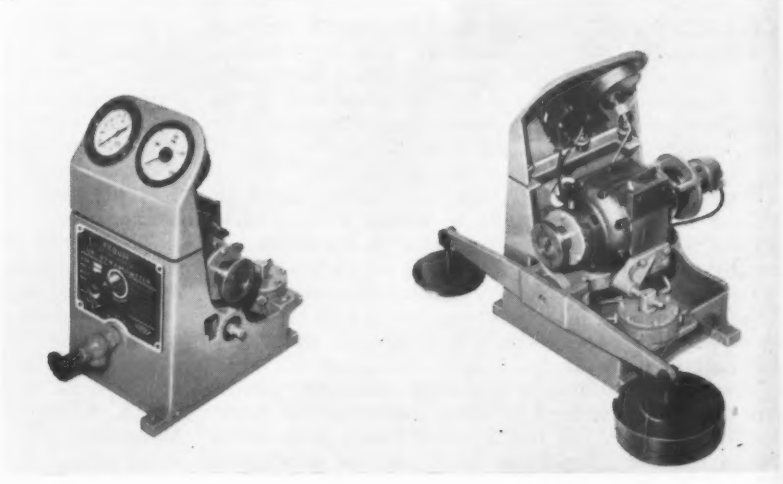
To meet these requirements, Heenan and Froude Ltd., of Worcester, are now in production with a new range, known as the I.E. brake or dynamometer. The basic conception is of a brake unit on general Froude principles, without torque measuring equipment, and with cast-iron feet to bolt directly to the user's bedplate or foundations, when only a simple power-absorbing unit is required. It can be converted into a full-scale dynamometer by mounting it on a pivoted platform and fitting a lever arm for measuring the torque-reaction forces.

The brake unit itself has novel features. Its power-absorbing elements (rotor and stator) embody standard Froude practice, but are of the single-side type instead of the more familiar double-side form. The resulting axial thrust is self-contained, and is well within the capacity of the brake bearings. It can, in fact, be ignored. The load control gear is also a departure from the sluice-gate type previously used in the smaller sizes of Froude dyanmometers. In this new development, the load at any particular speed depends upon the quantity of water discharged into the brake casing by a pump impeller mounted on the brake shaft. This quantity is regulated by a hand-valve fitted on the casing. Control is very stable and convenient. These two features, that is, the single-sided power elements and the control gear, permit a greatly simplified and therefore very economical construction for a power-absorbing unit, and also for an inexpensive complete dynamometer.

A novel contribution to this latter is the design of the pivoting gear that makes it possible to measure the torque reaction on the brake casing. In previous and conventional designs of small dynamometers, the casings have been allowed the necessary rocking motion between no-load and full-load by mounting them on trunnion bearings. These bearings normally surround the shaft and, therefore, have to be of relatively large diameter. In the I.E. design, they are replaced by pivot bearings placed vertically below the shaft axis, and thus can be made much smaller. The resulting slight movement of the shaft itself necessitates the use of a universally-jointed cardan shaft between the engine and the dynamometer. However, such shafts are normally used in any case, and the type usually employed is easily capable of accommodating the movement.

The brake unit on its pivoted platform is provided with a short lever arm that bears upon a pressure capsule, which is coupled by small-bore piping to a pressure gauge calibrated to give torque readings. From these readings and the tachometer readings of speed, the power absorbed can be calculated. Either British or metric units of horse-power may be specified. At full torque the accuracy is within plus or minus one per cent.

Normally, the torque dial and speed dial are fixed to the standard panel, which is itself flexibly attached to the dynamometer bedplate. The torque dial is provided with 20 ft of piping so that it may be mounted remote from the dynamometer if so desired. The tachometer is of the electric type, and extended wiring to a remote station will not affect its accuracy. A device can be supplied for quickly checking the accuracy of torque readings. It consists of a quick-fixing lever arm and dead weights. As weights are added one by one, the torque readings should, of course, follow consistently. Three sizes of brake and dynamometer are at present available, ranging from 25 h.p. at 4,600/6,000 r.p.m., to 100 h.p. at 2,500/4,000 r.p.m.



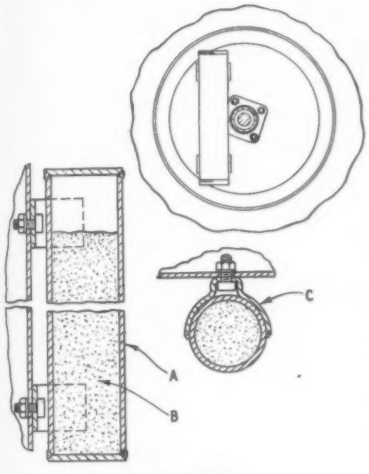
One of the new range of Heenan and Froude I.E. dynamometers. Where actual measurement of torque is not required, the brake only can be supplied at a substantial saving in first cost

CURRENT PATENTS

A REVIEW OF RECENT AUTOMOBILE SPECIFICATIONS

Wheel damper

A container partially filled with a high-density granular material and secured to a non-rotating part of the wheel assembly provides an inexpensive and simply-manufactured damper. The illustration shows the application to a vehicle rear wheel. It comprises a hollow, partitionless cylinder A closed at each end by a circular plate welded in position. Within the container is a quantity of finely divided or powdered material B, which is preferably



No. 772130

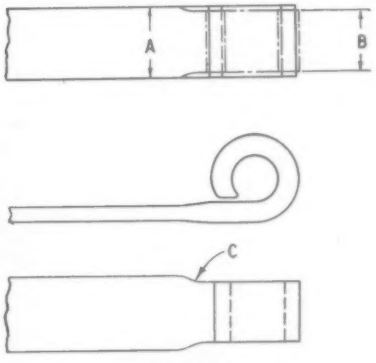
iron or other metallic filings. The damper is furnished with welded-on brackets C, carrying bolts by which it is attached to the brake back plate.

In operation, as the wheel and the cylinder oscillate at relatively high frequency, the powdered material tends to remain stationary and thus, relative to the cylinder, to oscillate out of phase with the frequency of the wheel hop oscillation. Energy induced by wheel hop is expended and dissipated as heat in overcoming the frictional drag of the powder on the cylinder walls, by impact of the powder on the end closures, and by rubbing action between the powder particles.

An alternative design, shown in the specification, has a large diameter, shallow cylindrical container mounted coaxially on the end of a front wheel stub axle. If desired, it can be shaped to conform to the face of the wheel or to simulate the conventional hub cap or wheel cover. *Patent No.* 772130. *General Motors Corporation* (*U.S.A.*).

Laminated spring

The top leaf of a laminated spring tends, under heavy stressing and horizontal shock, to fracture in the vicinity of the rolled eyes. This has been circumvented by upsetting the ends to form solid eyes or by producing a leaf of greater thickness than necessary and then milling it down to an appropriate thickness between the eyes. Both methods are costly and time-absorbing. The invention provides eyes



No. 772111

of greater thickness than the leaf at a lower cost than hitherto.

A leaf blank is provided with rolled eyes in the conventional manner, as at A in full line. Then swaging tools are applied simultaneously to each side of the eyes to reduce locally the width of the eyes and increase their thickness, as at B in broken line. The tools are designed to provide a smooth transition at C from the original width of the leaf to the reduced width of the eye. Subsequently, the eye may be treated or machined; for the reception of a threaded bush for the spring pin, for example. *Patent No.* 772111. *Daimler-Benz A.G.* (*Germany*).

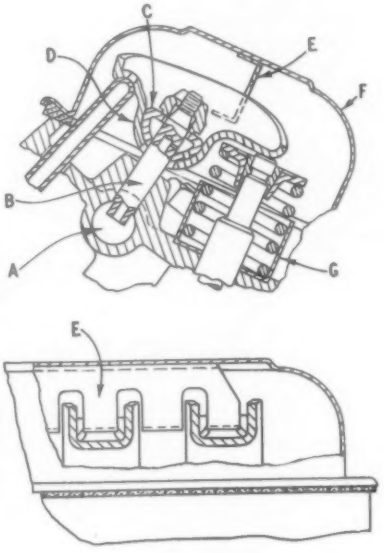
Overhead valve actuating mechanism

In this pushrod-operated valve gear each rocker lever is directly and independently mounted on the cylinder head so that any distortion of the head will not materially affect the adjustment of valve clearance. Arrangement is made to ensure, in the event of a valve sticking in its guide, that the rocker lever cannot become disengaged.

The upper wall of the cylinder head is formed with a tubular longitudinal beam A, which may serve as an oil gallery, and externally this beam is bossed to receive the pressed-in rocker support studs B. Between the valves for each cylinder, the beam is additionally supported by the internal column bosses accommodating head holding-down bolts. Each stud is fitted with a head, comprising a cone-seated, self-locking nut, against which a hemispherical bearing member C is abutted.

Rocker levers are pressed from sheet metal, with a peripheral flange and a hemispherical depression D which forms a seating bearing on member C. This construction permits the lever to rotate as well as to oscillate but, during normal operation, rotation is prevented by the hemispherical end of the tubular pushrod engaged in a complementary socket in the end of the lever. Should a valve stick, any possibility of the lever rotating out of engagement is prevented by a channel member E, attached to the valve gear cover F, which is notched to engage the lever with appropriate clearance. The valve springs may be seated in damping cups G, as shown.

Lubrication is arranged by feeding oil up the hollow pushrod and discharging it through drillings in the rod and the socket to the interior of the pressed lever. It flows to the hemispherical bearing and to the opposite end of the lever, where it escapes over the flange and to the valve stem. Alternatively, the oil may be fed



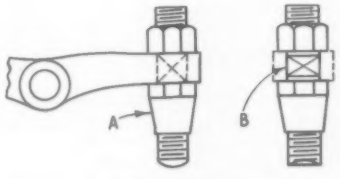
No. 772162

to the tubular beam A, whence it passes by drillings in support stud B to the hemispherical bearing and floods the rocker pressing. *Patent No.* 772162. *General Motors Corporation* (*U.S.A.*).

Valve adjuster screw

To facilitate the adjustment of valve clearance, this screw is arranged to be slidable but not rotatable in the end of the rocker lever. The screwed adjuster A is formed from square-section rod, leaving a mid-portion B un-machined. The axial length of this portion is approximately 0·125 in less than the depth of the rocker lever end boss, in a squared hole in which it is slidably engaged. On each of the screwed ends of the adjuster is fitted a nut; the lower one may be coned, as shown, to provide clearance over the valve spring retainer.

At its lower end engaging the end of the valve stem, the adjuster is suitably radiused and hardened. To take up excessive

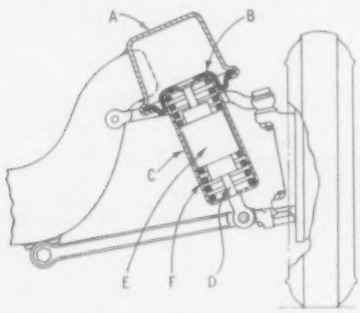


No. 769874

clearance, the upper nut is slackened off and the lower nut advanced until correct clearance is established. The upper nut is then tightened down to secure. *Patent No.* 769874. *W. A. Begley.*

Air suspension spring

By combining a dynamic absorber with an air spring in a wheel suspension system, the inherent advantages of air suspension are retained and the absorber controls wheel oscillation. The wheel is carried on a conventional transverse wishbone arrangement with a ball-type steering head. To the end of the frame cross member is welded an inverted cup A forming a rigid part of the air spring chamber. At its lower peripheral edge, the cup has a U-shaped circumferential flange, in which is secured the outer periphery of a resilient diaphragm B. The inner periphery of this diaphragm is bonded to the end wall of a hollow cylinder C constituting the piston for the air chamber. As the wheel rises, relative to the frame, the cylinder is displaced upwardly by the lower wishbone arm and compresses the air in the chamber. Since the diaphragm is annular, the upper end of the cylinder is maintained substantially concentric with the cup A.



No. 772230

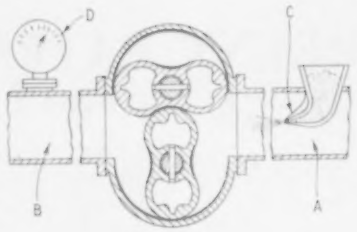
The hollow cylinder is fitted with an axial guide rod D, on which is slidably mounted a weight E. Between the weight and each end of the cylinder is one of a pair of helical springs F, which normally centre it resiliently. These springs are tuned to cause the weight to oscillate out of phase with the frequency of wheel oscillation and thus to counteract wheel hop.

To increase its effectiveness over a wide range of operating conditions, the diametral clearance between the weight and the bore of the cylinder is selected to restrict the rate at which air is transferred from one end of the cylinder to the other. *Patent No.* 772230. *General Motors Corporation.* (*U.S.A.*).

Improving blower efficiency

Manufacturing inaccuracies and bearing wear in a Roots-type blower result in excessive clearances, between the rotors themselves and between the rotors and the casing, which provide paths for the escape of air and thus lower the volumetric efficiency of the unit. The invention relates to a means of reducing these clearances to the minimum necessary for operation and to a method of applying the sealing material. Suitable materials are colloidal graphite, lead, tin, zinc, nylon or varnish.

The blower to be treated is connected between an air intake pipe A and a pressure pipe B, which is in communication with a



No. 772350

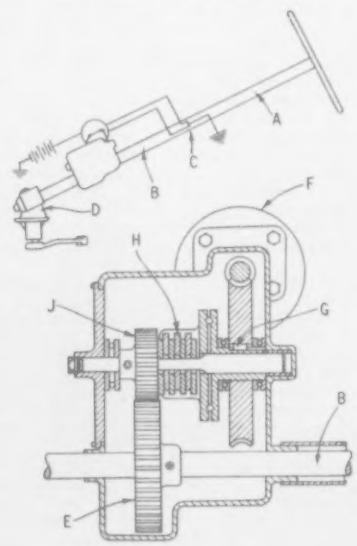
container. A vaporizing nozzle C, with a vessel holding the adherent sealing material, is arranged in the intake pipe. When the blower is driven by any suitable means, the sealant is drawn in through the nozzle, vaporized, and entrained in the air stream. It is deposited on the rotors and on the interior of the casing wherever there is sufficient room, and the working clearances are progressively reduced.

The improvement in efficiency can be indicated by a gauge D recording the pressure in the delivery container. When the desired value has been attained, heated air may be passed through the blower to dry and harden the sealant or to remove any solvent. The blower can then be taken off the rig and returned to service. *Patent No.* 772350. *Hanomag A.G.* (*Germany*).

Electric power-assisted steering

This assisted steering system comprises a reversible electric motor, a clutch for connecting the motor to the steering mechanism, and a lost-motion connection between the motor and the clutch, which permits the motor to accelerate or decelerate independently upon energization or de-energization.

The primary steering shaft A drives a secondary shaft B through a lost-motion coupling indicated at C. Shaft B, driving the conventional steering gear D, is mounted in the booster housing and carries a gear E to receive the power drive. A reversible motor F, mounted on the housing, drives through a worm reduction gear and a lost-motion connection G a ball-and-cam clutch that actuates the multi-plate clutch H in either direction of



No. 772682

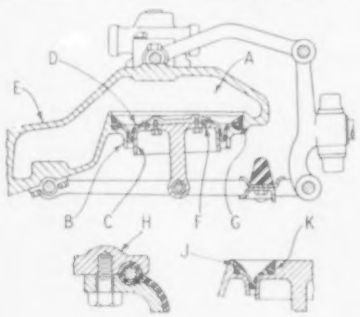
rotation. Gear J transmits the motor drive through gear E to the steering gear.

In operation, a predetermined torque in either direction on steering shaft A will cause relative rotation with shaft B and close contacts which energize the motor to rotate in the appropriate direction. In taking up the drive, the worm wheel is permitted about 30 deg rotation by the lost-motion connection G before a positive drive is initiated. *Patent No.* 772682. *Thompson Products Inc.* (*U.S.A.*)

Fluid suspension spring

In this fluid pressure spring, cylinder and piston are interconnected and sealed by a flexible diaphragm which is turned completely inside out in a full stroke of the piston. The diaphragm is so constructed that it provides sufficient restraint laterally to prevent it being pinched between the relatively moving elements and no auxiliary guiding means is necessary. The term "fluid" is intended to include either a gas, a vapour, or a liquid.

Springs for either front wheel or rear wheel suspension are essentially similar, and comprise a chamber A, a cylinder portion B, a piston C and a diaphragm D. Chamber and cylinder may, as shown, be



No. 773069

formed integral with a transverse frame member E. The free end of the piston rod is pivotally connected to the lower wishbone arm and consequently travels in an arcuate path tending to move the piston laterally against the wall of the cylinder. Such movement is opposed by the cup-shaped diaphragm, which is built up of a plurality of plies of a substantially weftless cord fabric, as is used in tyre casings. Individual cords may be of nylon, cotton, rayon, steel, glass, or other flexible but nominally inextensible material, and the fabric is coated with natural or synthetic rubber or a plastics material to render it impermeable to fluid. The cords in the individual plies are alternately laid in different directions at an angle between 15 deg and 75 deg.

Inner and outer margins of the diaphragm fabric are anchored respectively to substantially inextensible and incompressible bead wire bundles F and G. Connection to the piston is by means of a clamping plate H, and to the cylinder by a similar clamping of bead G if the cylinder portion B is formed as a detachable unit. It is preferred, however, in order to facilitate assembly, to seat bead G in a tapered extension J of the cylinder where it is secured in position by the fluid pressure in the manner of a tyre on a wheel rim. In an alternative arrangement this second method is also used for the attachment of the diaphragm to the piston, as at K. *Patent No.* 773069. *United States Rubber Co.* (*U.S.A.*).

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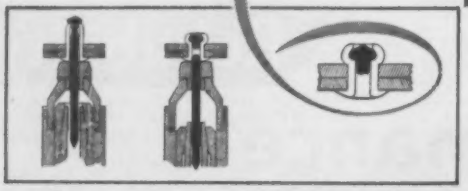

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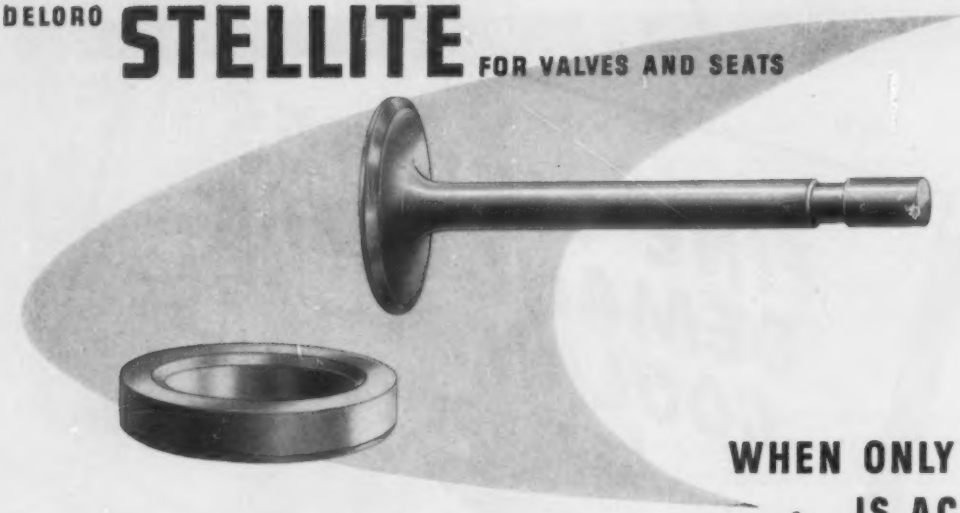

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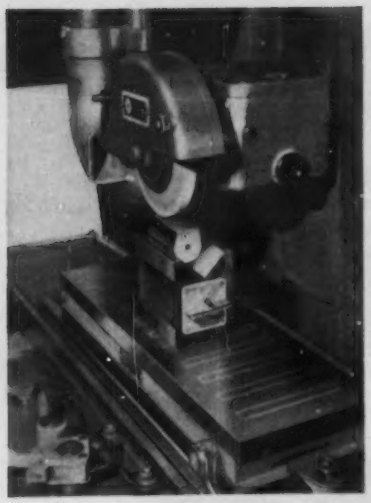

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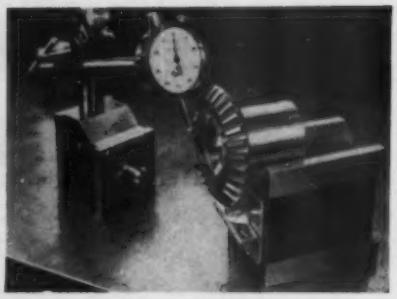

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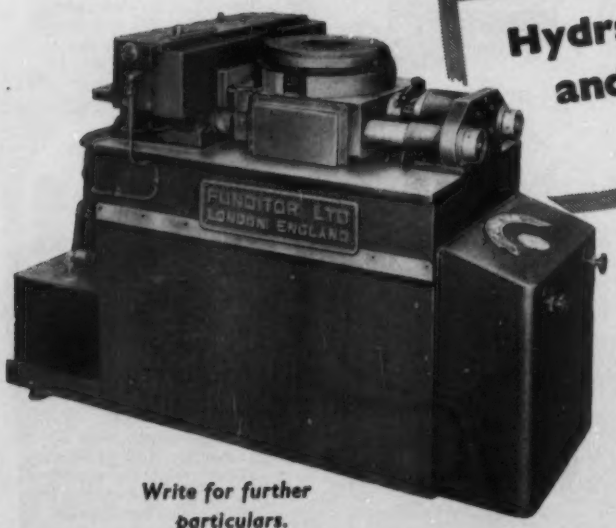

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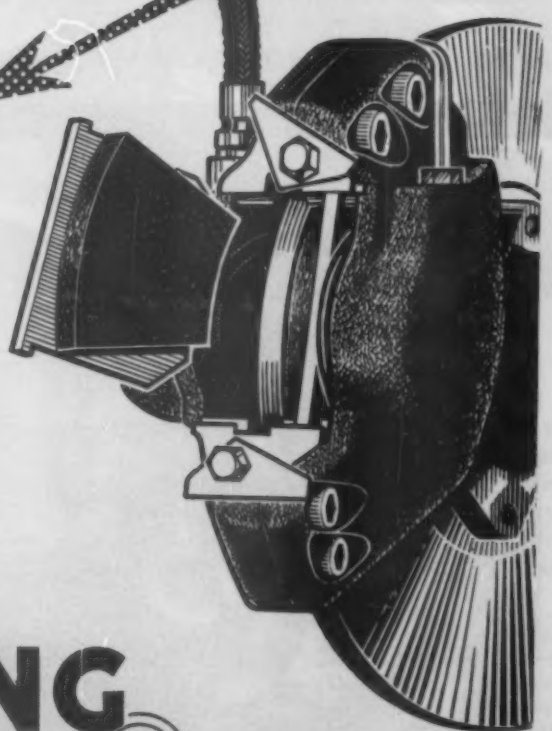

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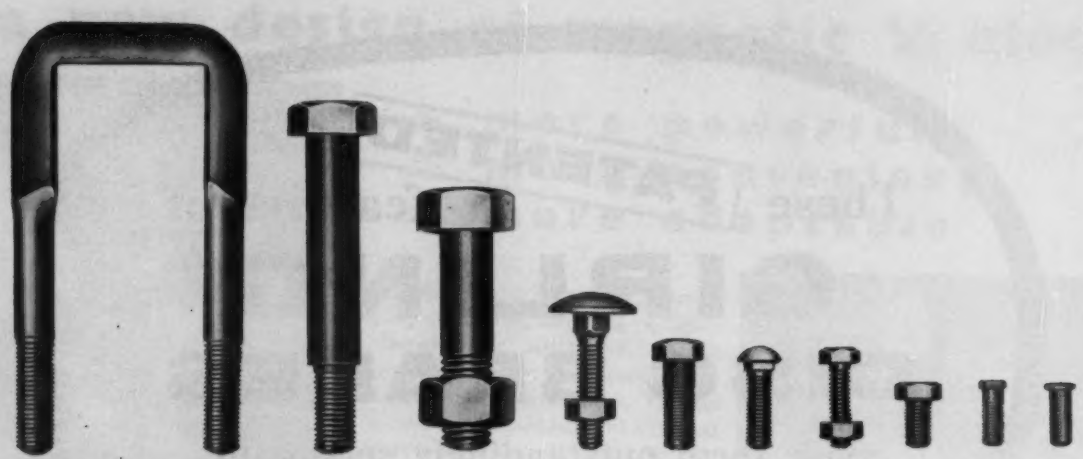

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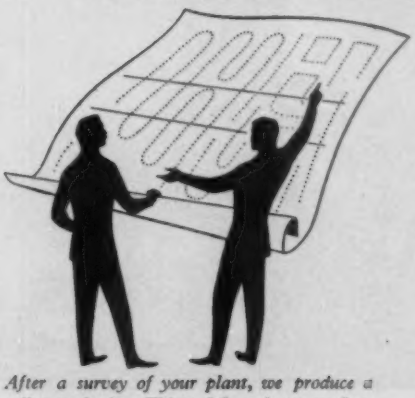

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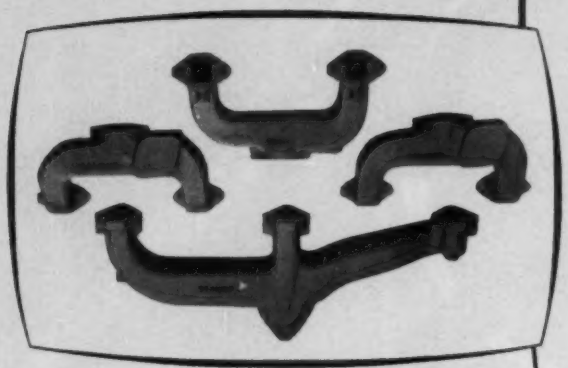

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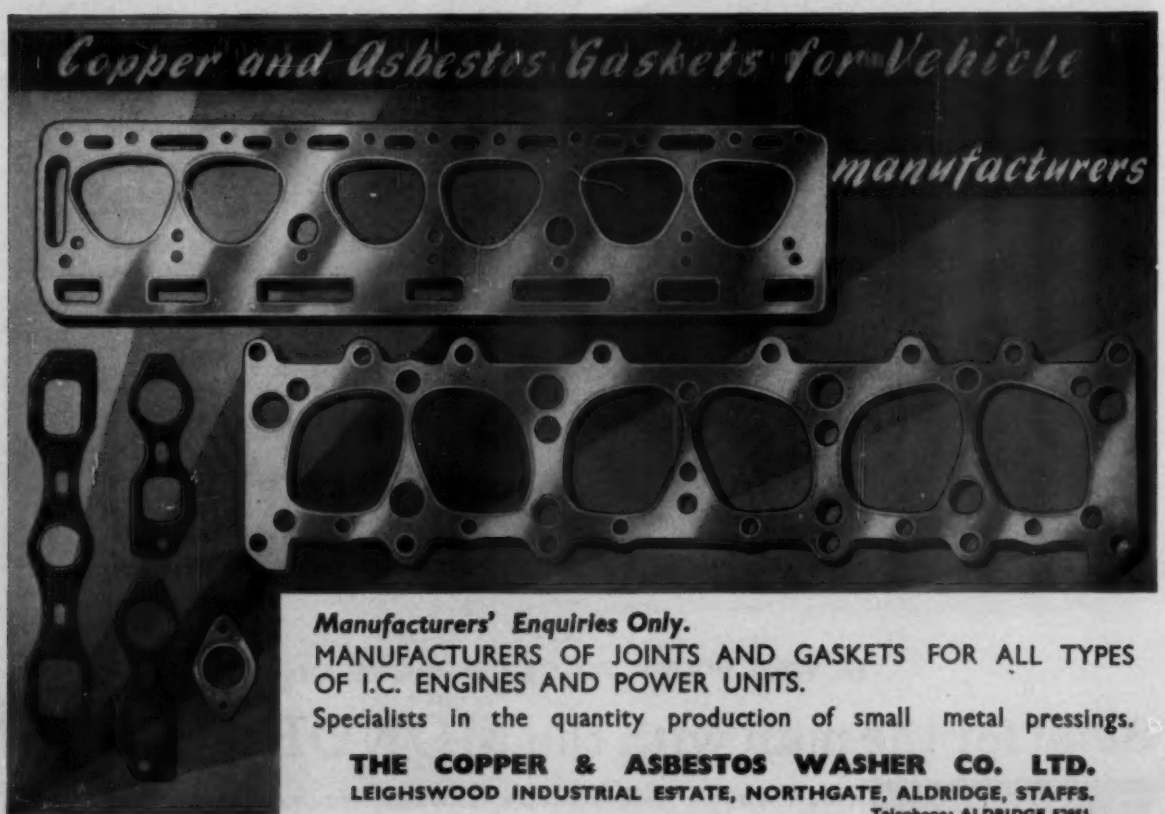

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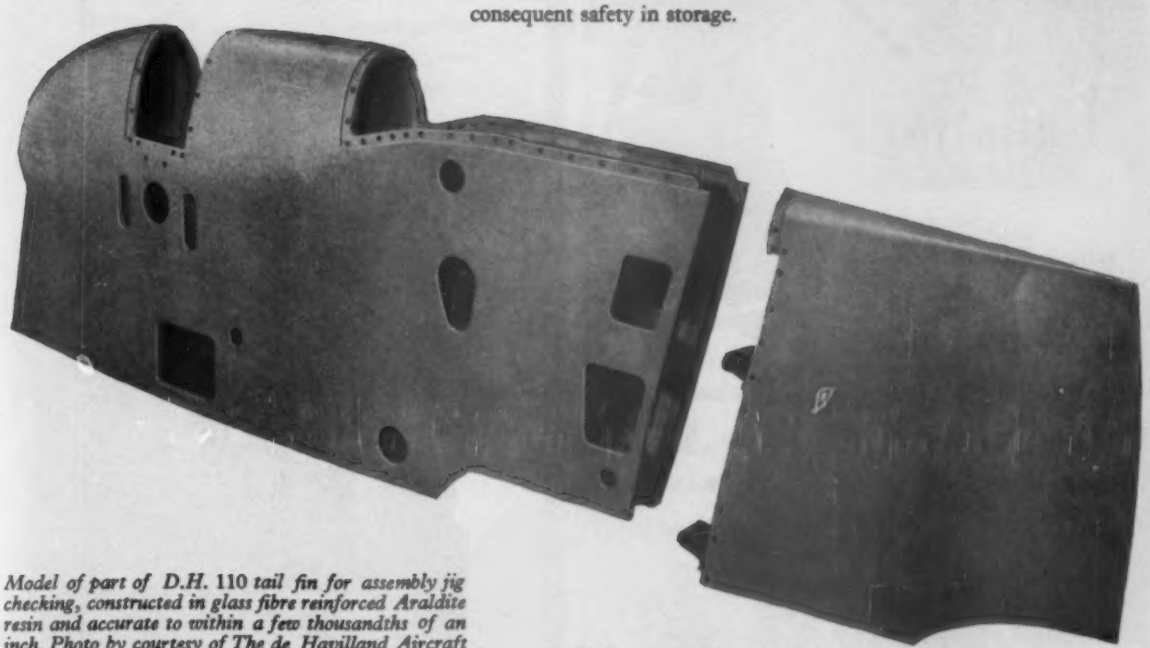
Tooling techniques with Araldite resins are being adopted more and more widely. Models, jigs, fixtures, patterns and metal-forming tools, including hammer forms, stretch blocks, rubber press tools, drop-hammer and draw dies, can all be made by simple methods with virtually no machining and a minimum of skilled manual work. Araldite tooling resins are used as gravity cast mineral-filled mixtures or with glass fibre mat or woven reinforcement, the latter providing strong, dimensionally stable, but lightweight surfaces and structures. Advantages of Araldite in tool-making include ease and speed of production, low production costs, light weight and ease of handling, negligible shrinkage on curing, accuracy of reproduction, dimensional stability, durability, resistance to cutting-oils and die lubricants, resistance to moisture and chemical attack, with consequent safety in storage.



Model of part of D.H. 110 tail fin for assembly jig checking, constructed in glass fibre reinforced Araldite resin and accurate to within a few thousandths of an inch. Photo by courtesy of The de Havilland Aircraft Co. Ltd.

The recommended techniques are simple and easily acquired. Full details and practical assistance are available upon request. May we send you a copy of our new publication on Araldite for tools, jigs and fixtures?

Araldite epoxy resins are used

- **for bonding metals, porcelain, glass, etc.**
- **for casting high grade solid electrical insulation**
- **for impregnating, potting or sealing electrical windings and components**
- **for producing glass fibre laminates**
- **for making patterns, models, jigs and tools**
- **as fillers for sheet metal work**
- **as protective coatings for metal, wood and ceramic surfaces**

Araldite *epoxy resins*

Araldite is a registered trade name

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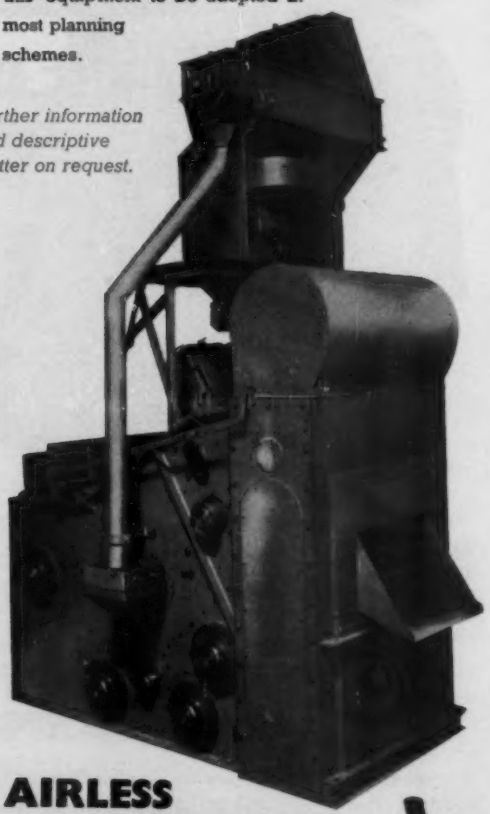

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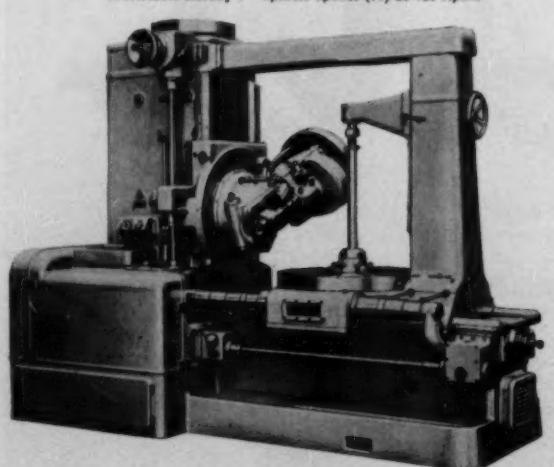

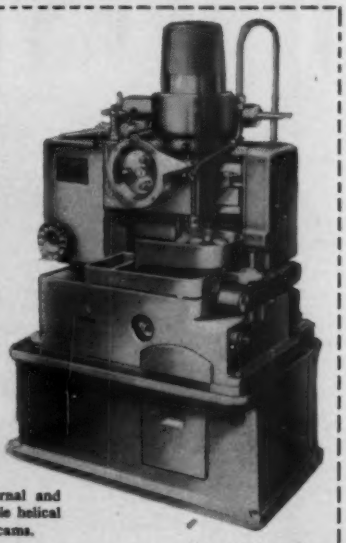

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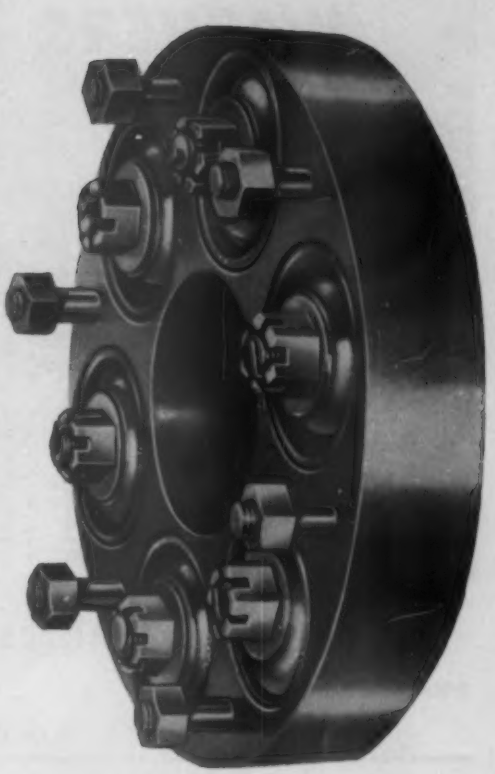

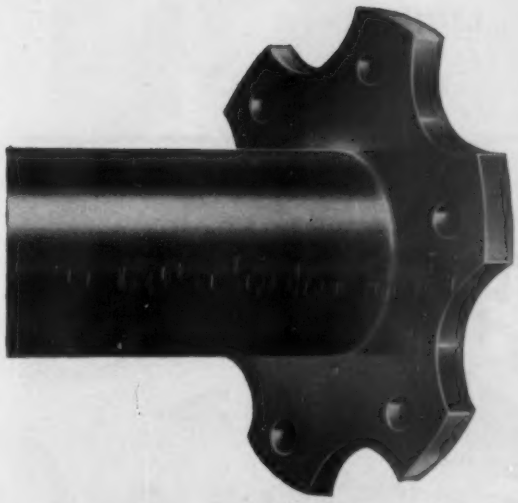

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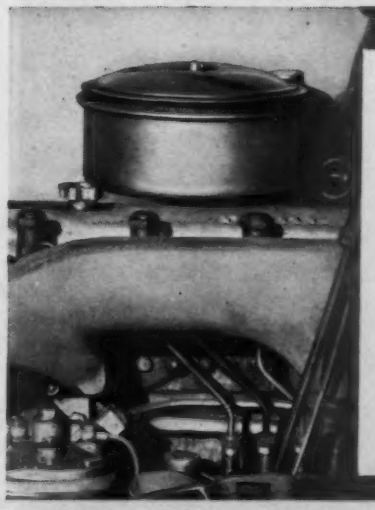

P6 Powered Commer does 112,000 miles without de-coke

Mr. M. B. Everley, joint director of Everley Bros. Ltd., Hayes, Middlesex, heavy haulage specialists, recently sent one of his fleet into the workshops to have new piston rings fitted. The vehicle, a 6-ton Commer with a Perkins P.6 engine, had done 112,000 miles fully loaded, without the head being removed. When the pistons were drawn it was found that every ring was free in its groove and clean.

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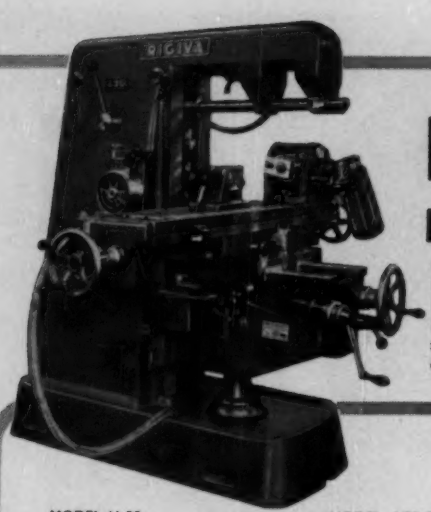

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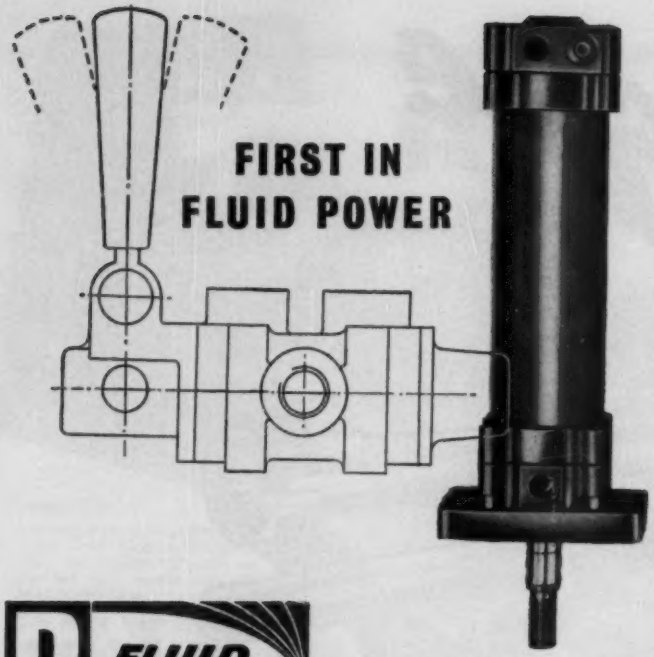

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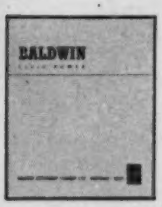

Write now for your copy of this new Fluid Power Brochure 9-503, it gives complete easy-to-read information on the entire range of Baldwin cylinders, valves and accessories, for pneumatic and hydraulic use.

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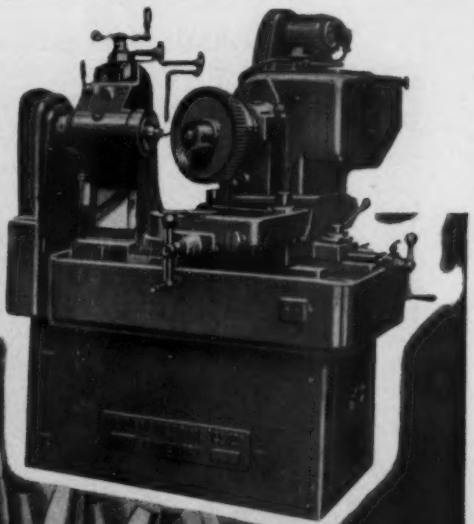

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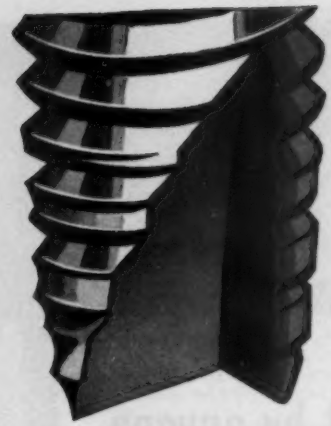

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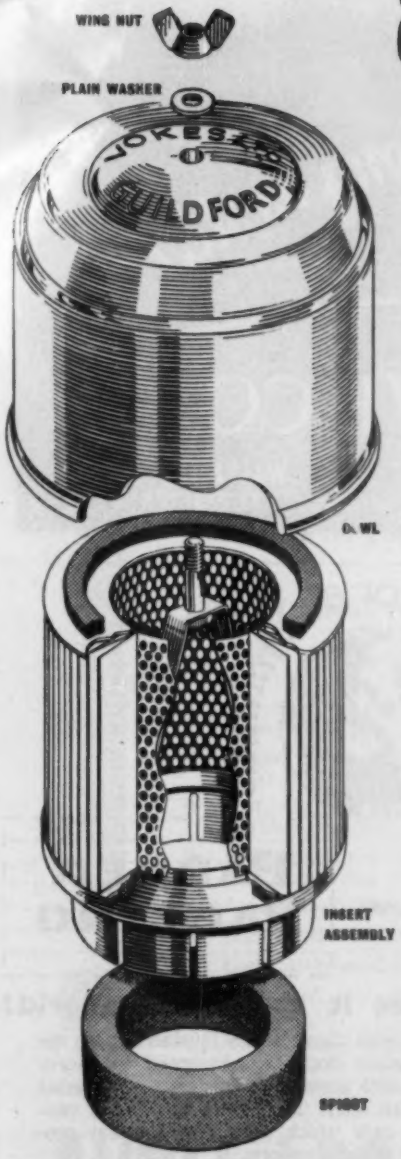

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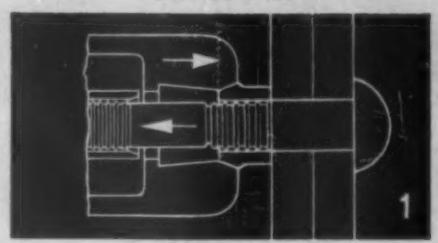
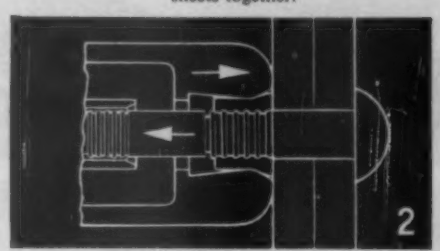
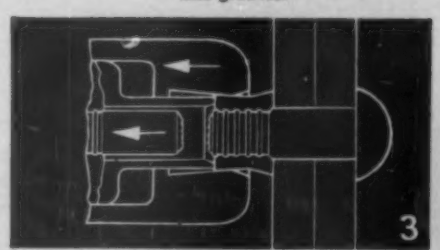


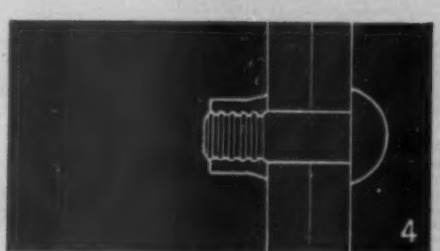
High clenching action clamps sheets together.



Collar swaged and locked into grooves.



Bolt breaks at breakneck groove.



Installed lock bolt.

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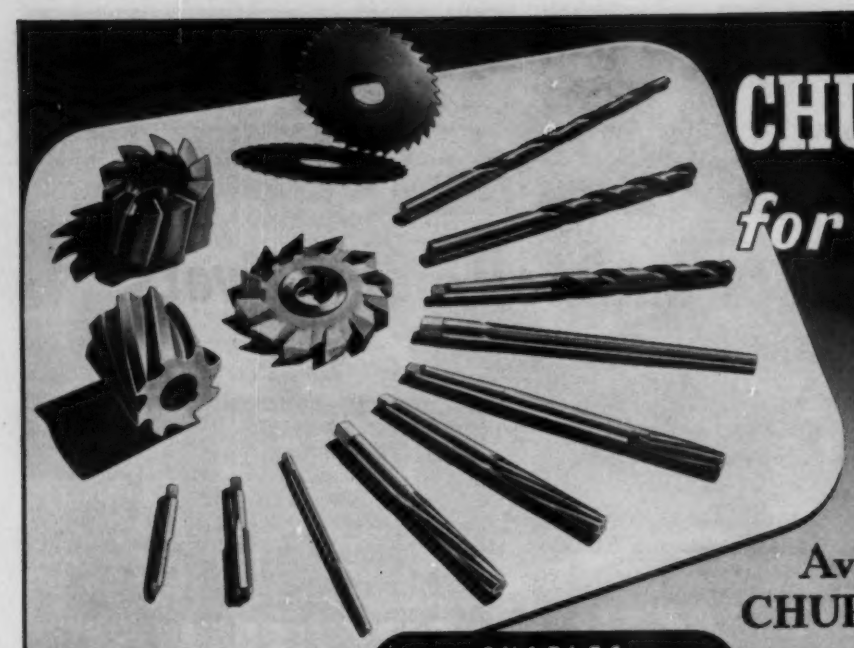

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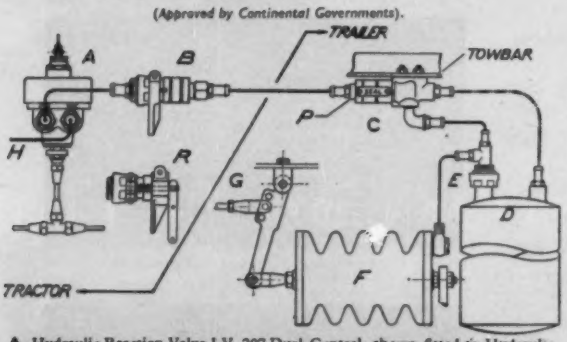

A. Hydraulic Reaction Valve LV. 207 Dual Control, shown fitted to Hydraulic Pipe Line on Tractor.
B. "C" type Coupling with Auto. Shut-off Valve, attached to rear of Tractor.
C. Breakaway Valve SBS. 256 (or SBS. 257) attached to Tow Bar of Trailer.
D. Vacuum Tank on Trailer.
E. Non-return Valve.
F. Power Unit on Trailer operating Brakes.
G. Trailer Brake linkage.
H. Hose connecting LV. 207 to source of Vacuum. Hose connections shown as solid lines are those used in normal operation of Brakes. The Hose shown in broken line connects the Vacuum Tank to the Power Unit when Valve "C" is operated in emergency.
P. Plunger with Safety Seal.
R. This assembly should be used in place of Coupling 'B', when Vacuum Pipe Line operating Trailer Brakes is common to that controlling Brakes on the Tractor.

Existing Trailer can be converted by adding "C", "D" and "E".

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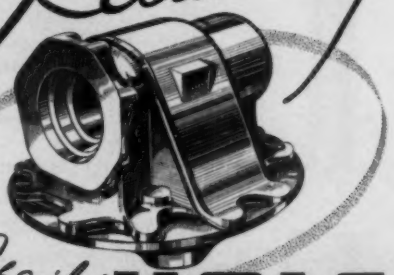

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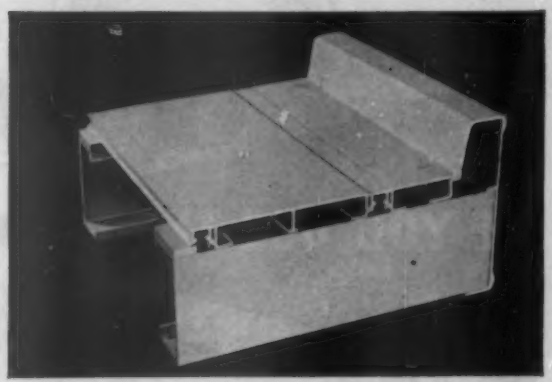

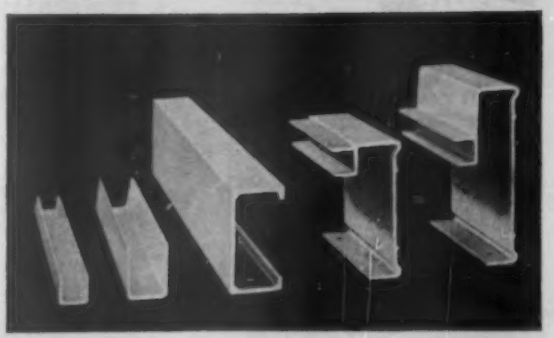

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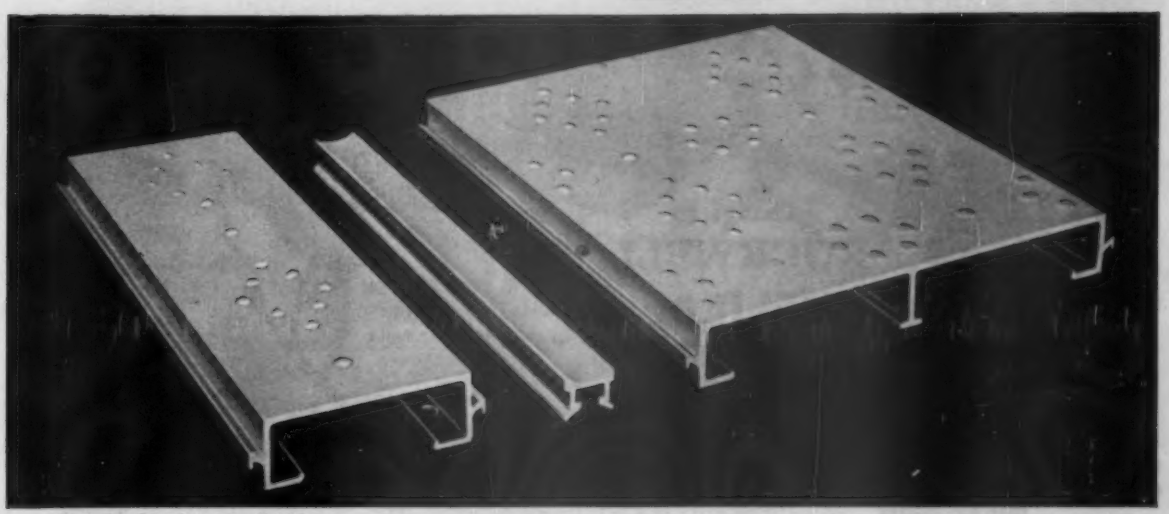

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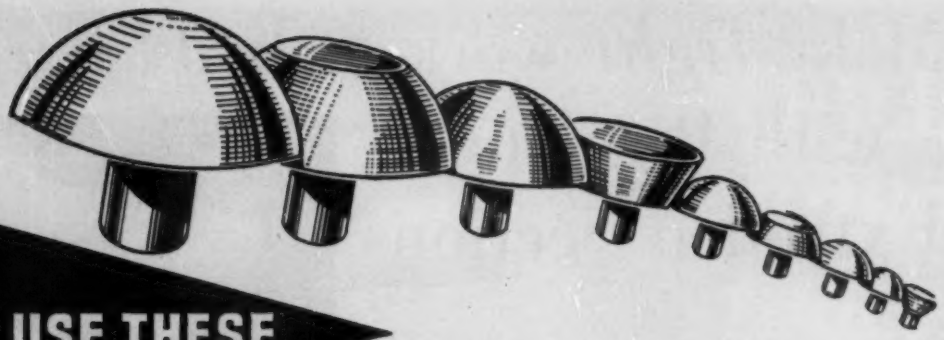

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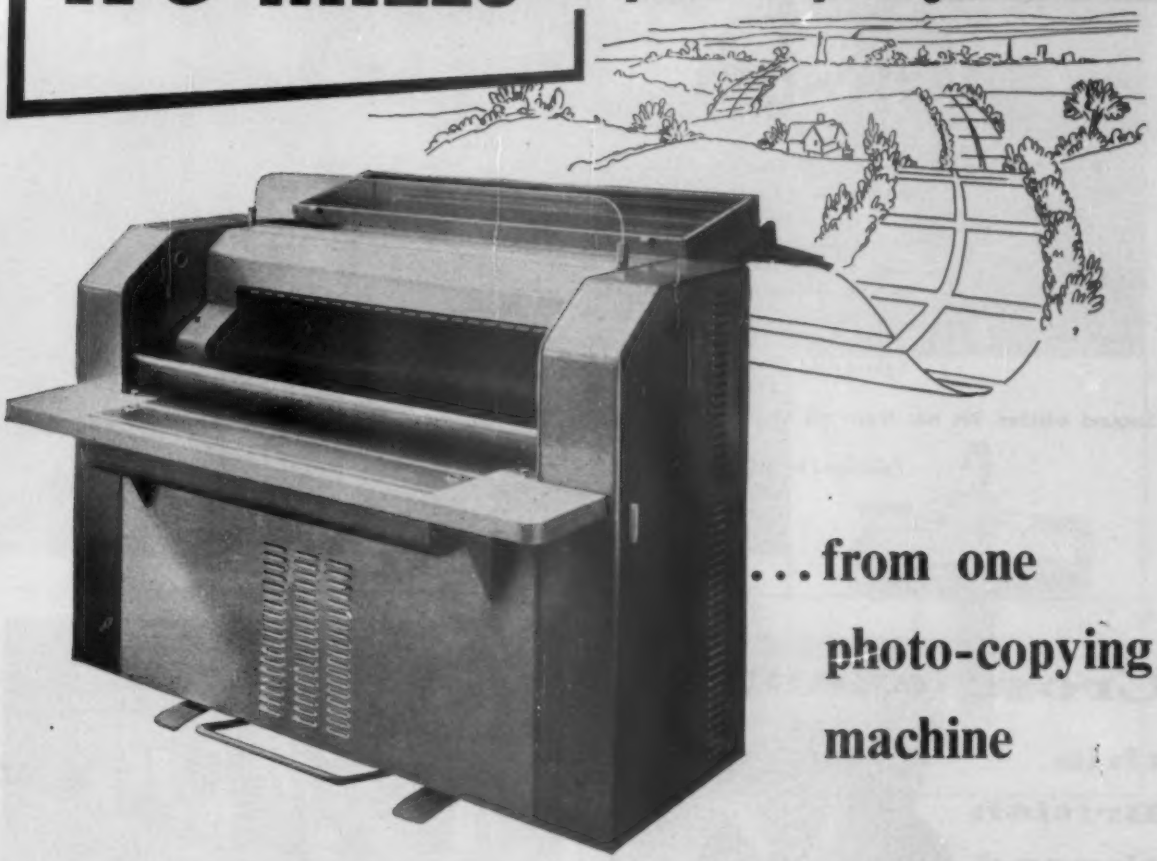

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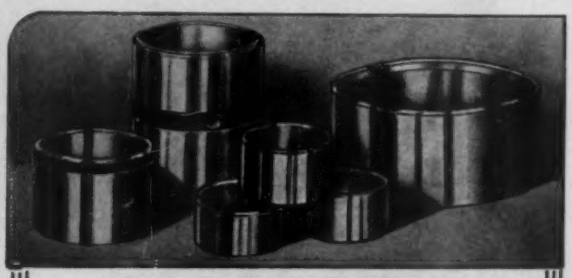

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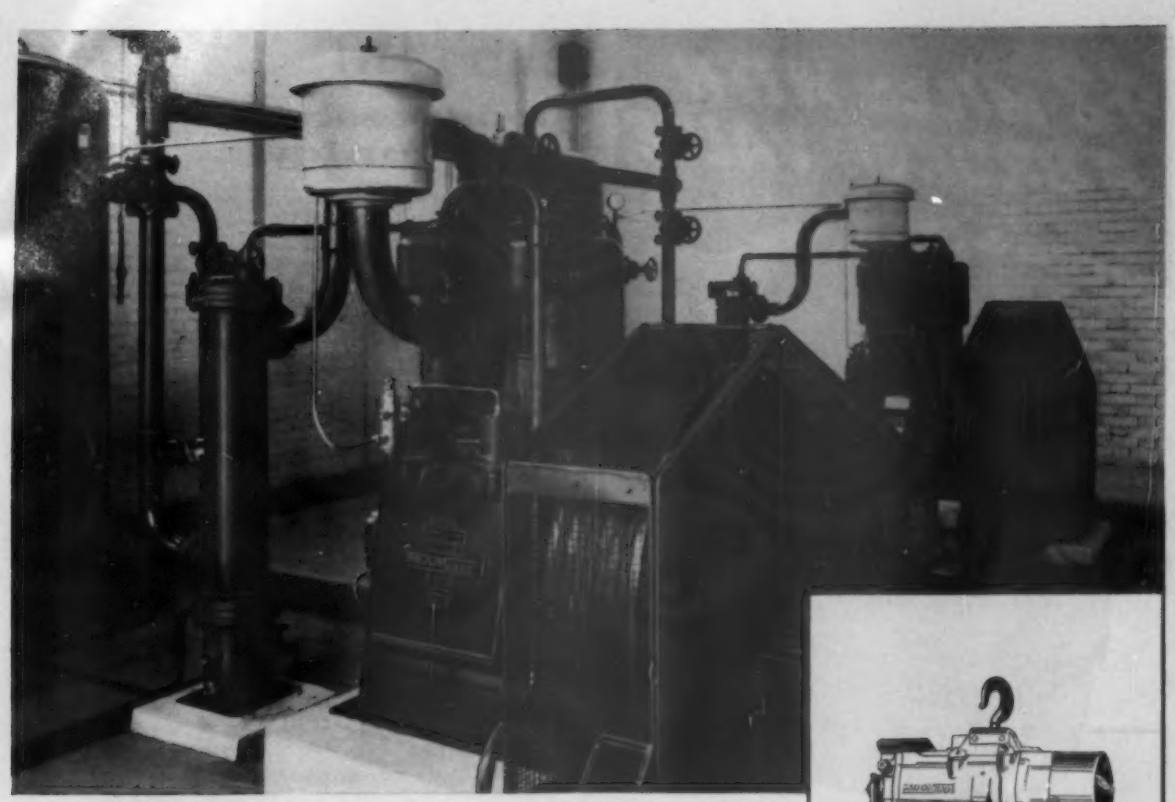

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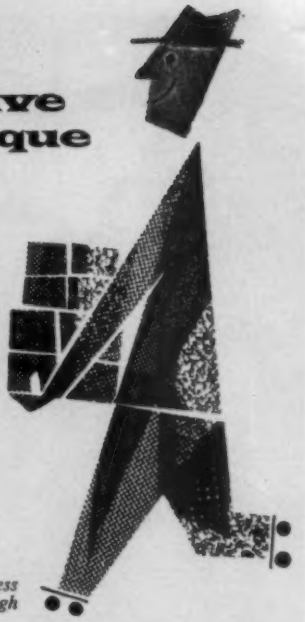

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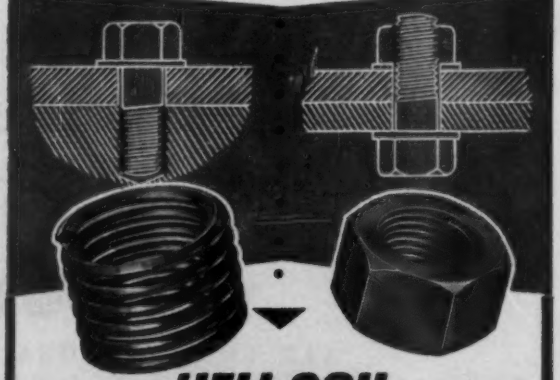

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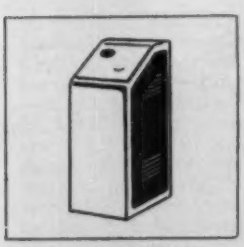

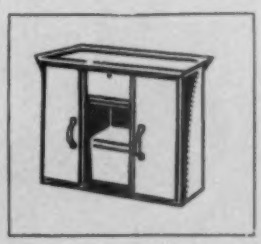

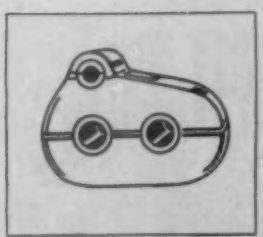

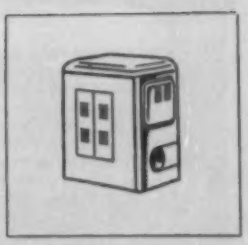

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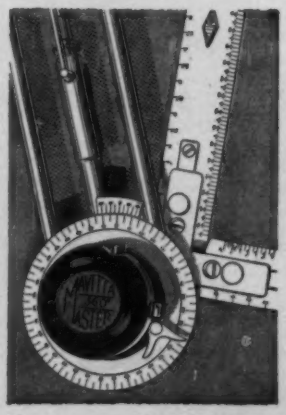

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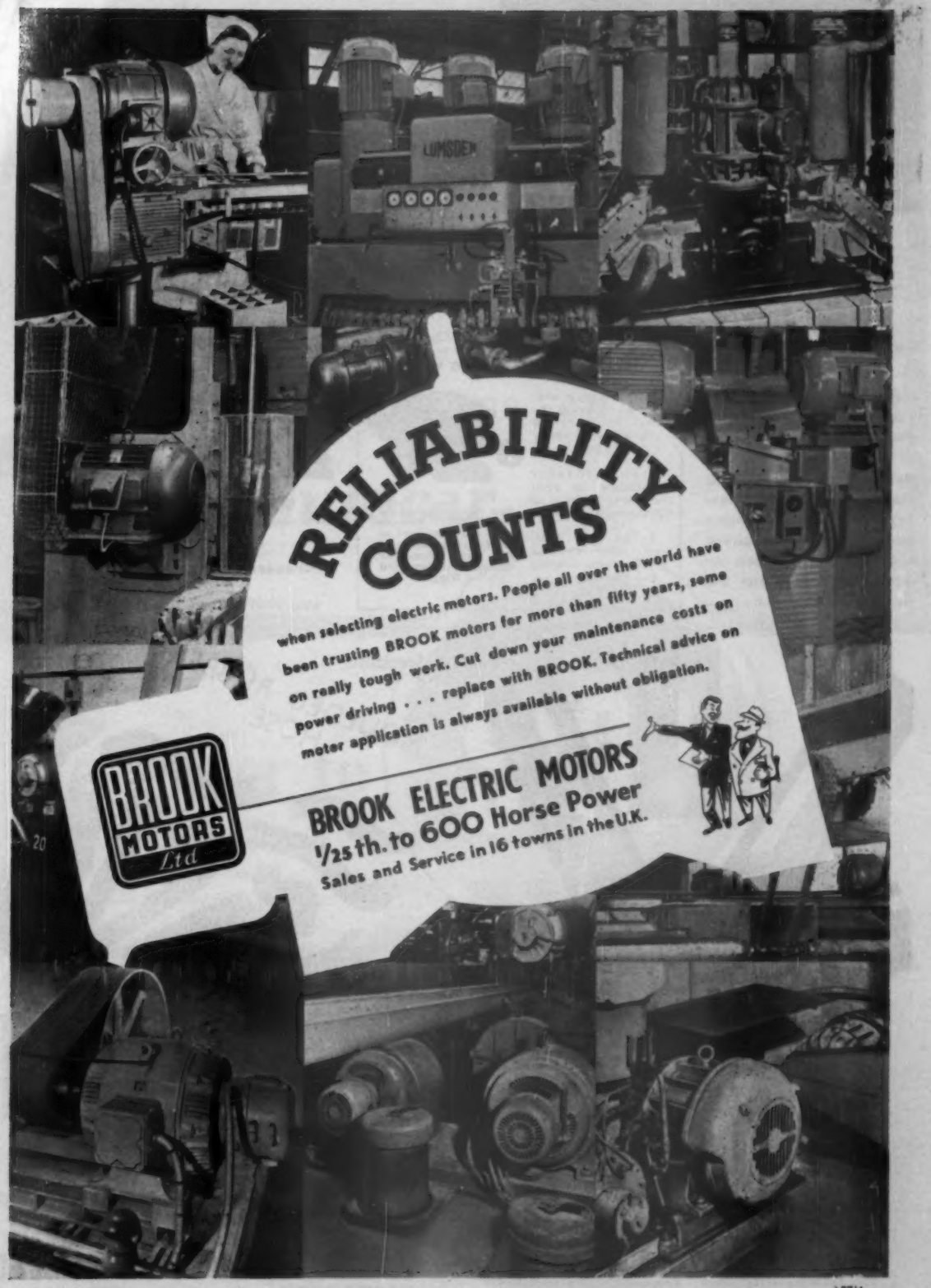
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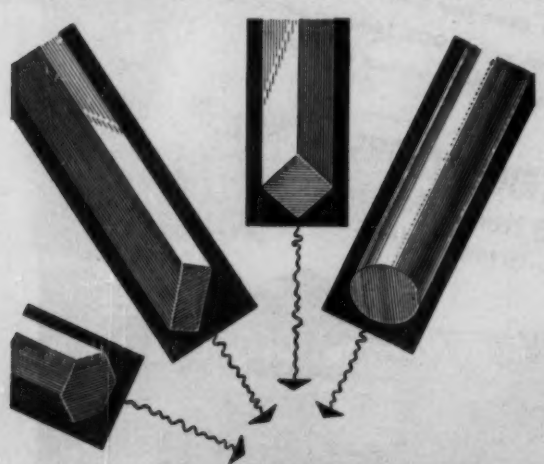

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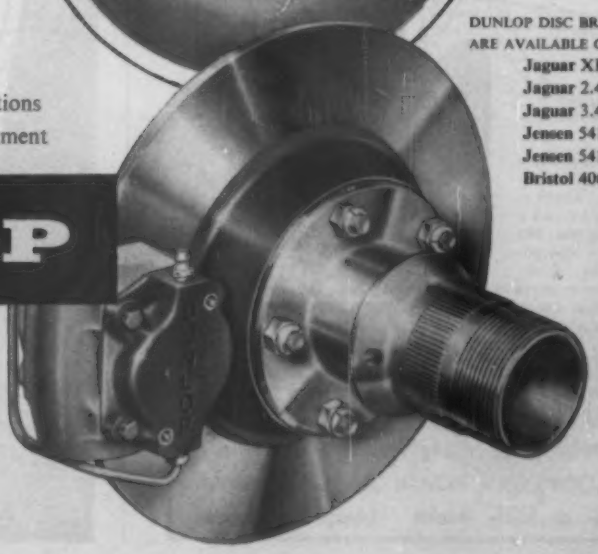

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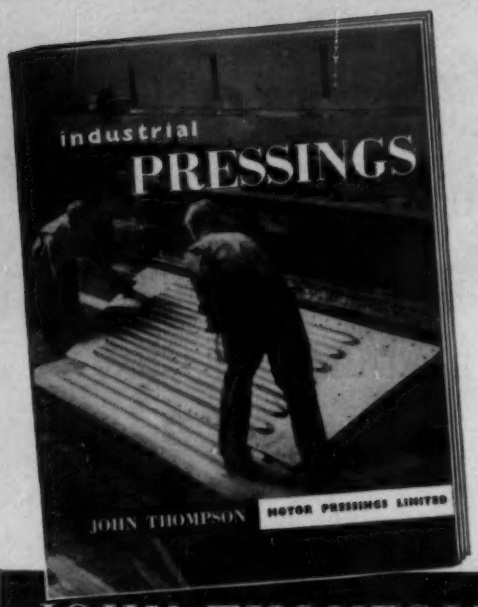

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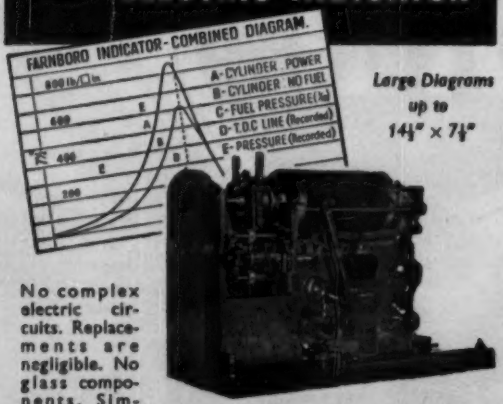

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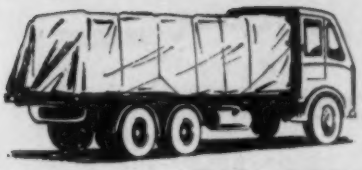

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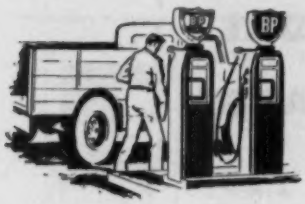

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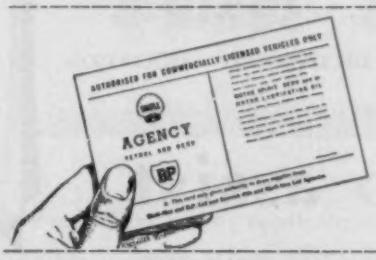

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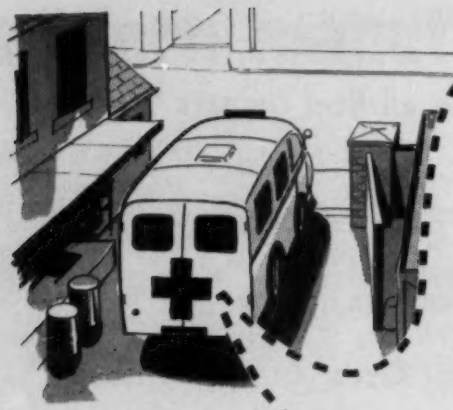

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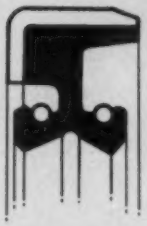

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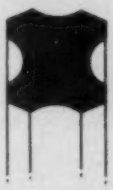

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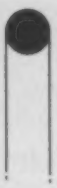

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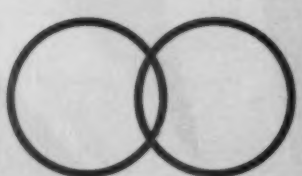

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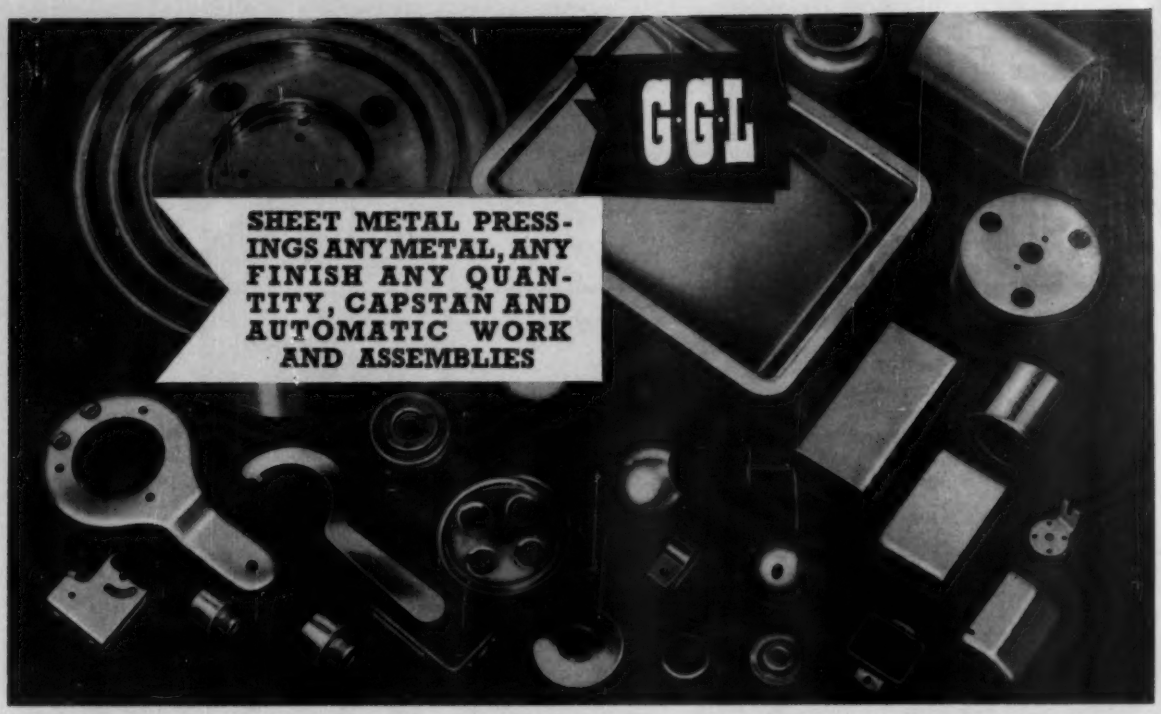

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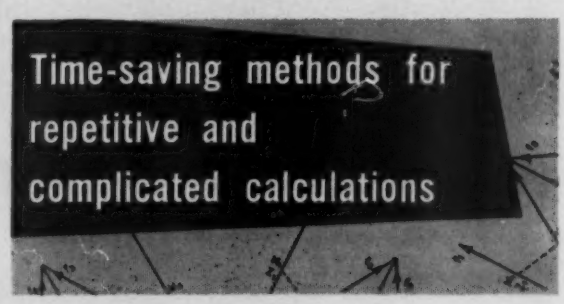

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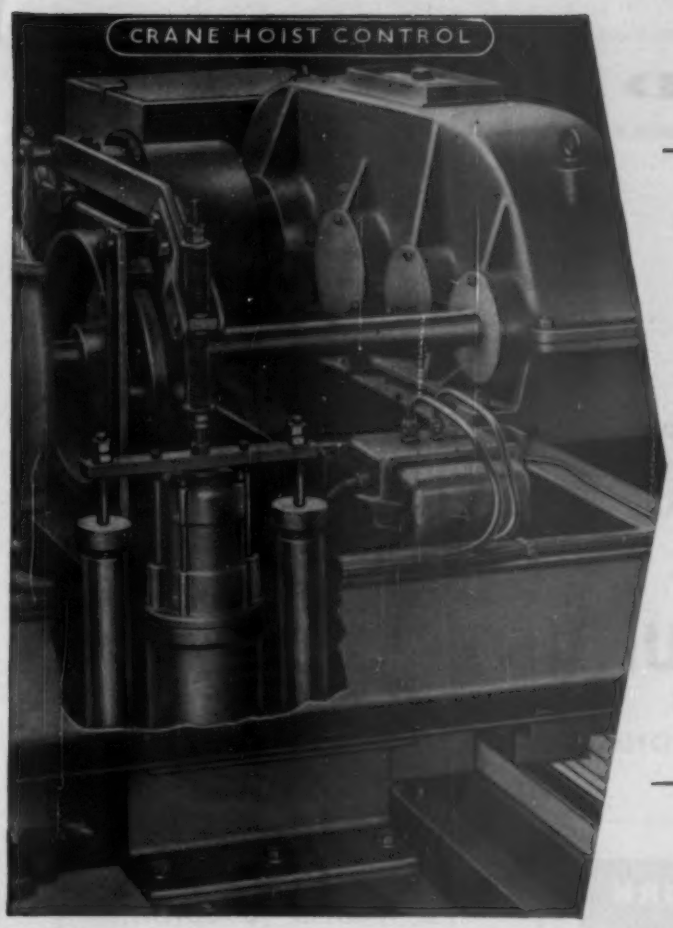

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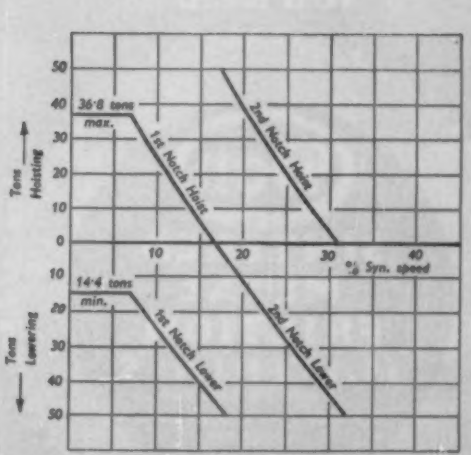

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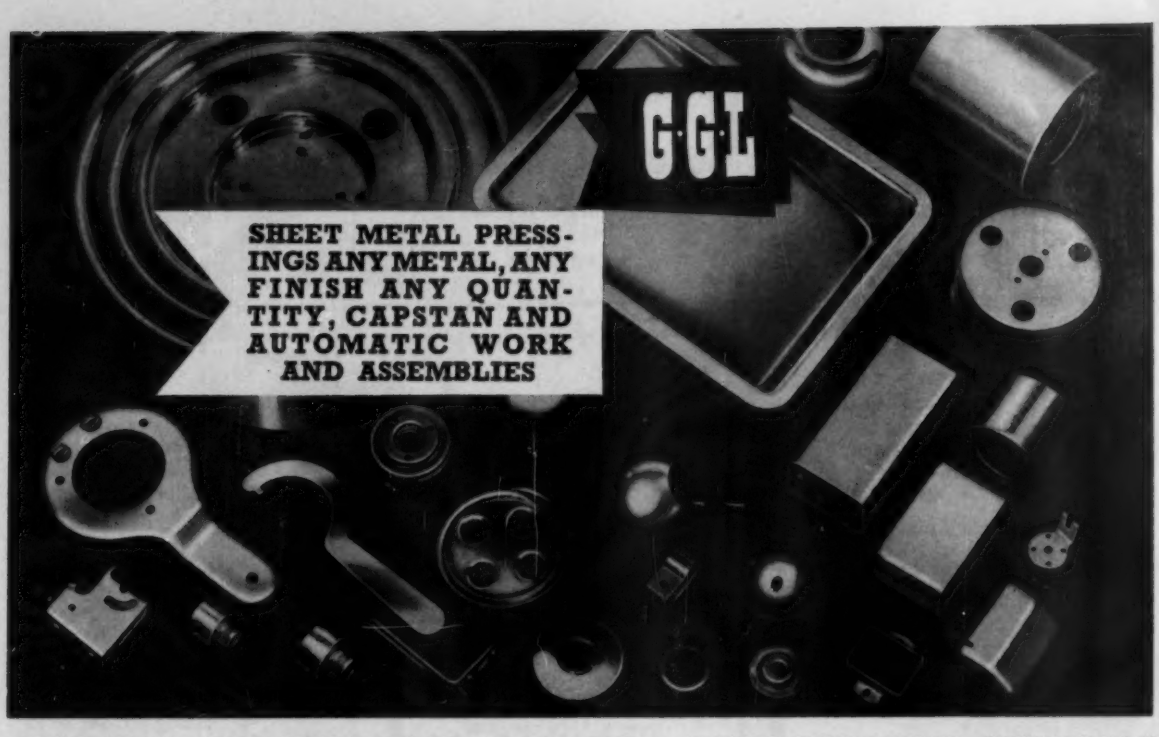

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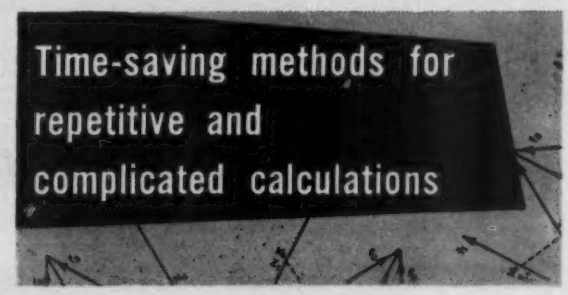

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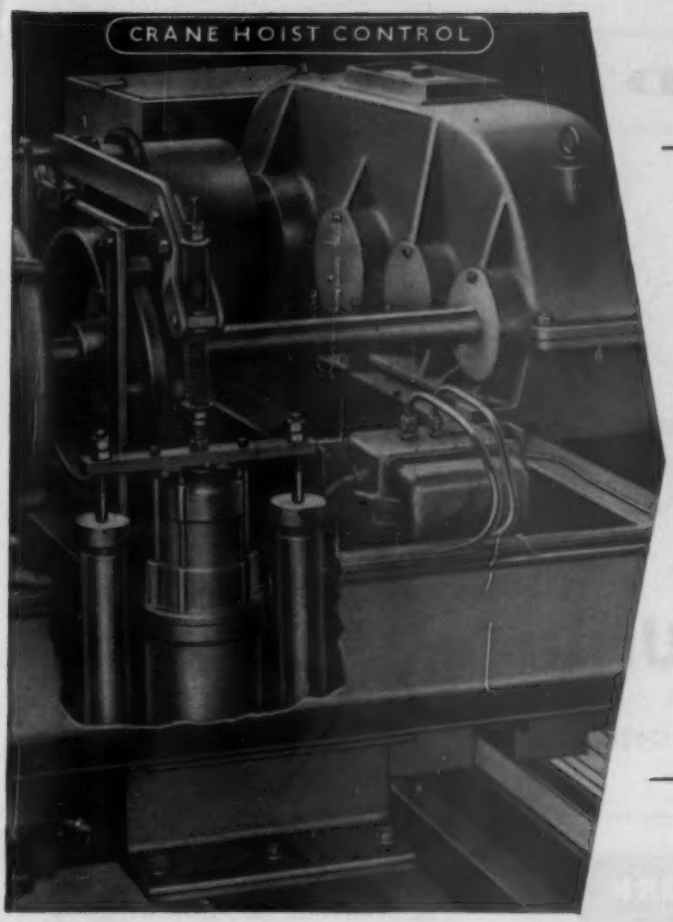

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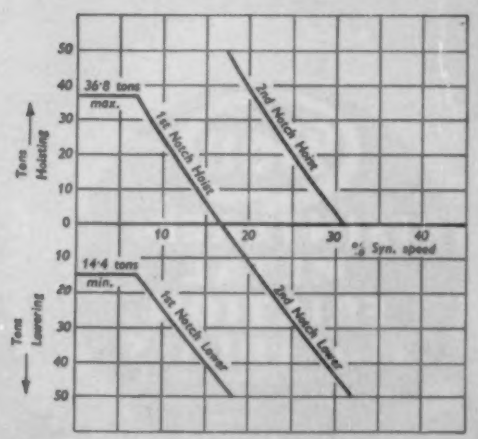

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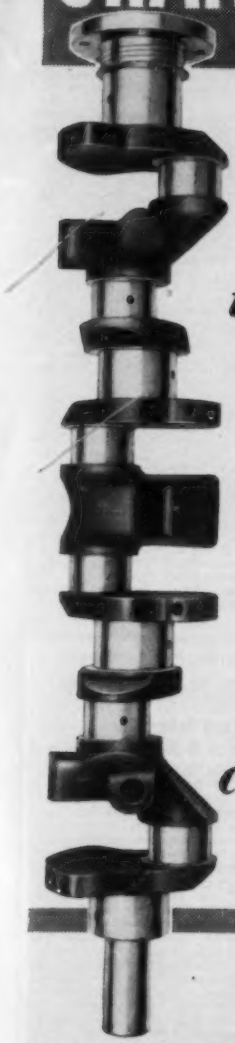

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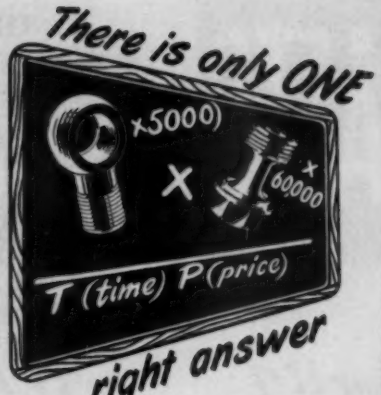

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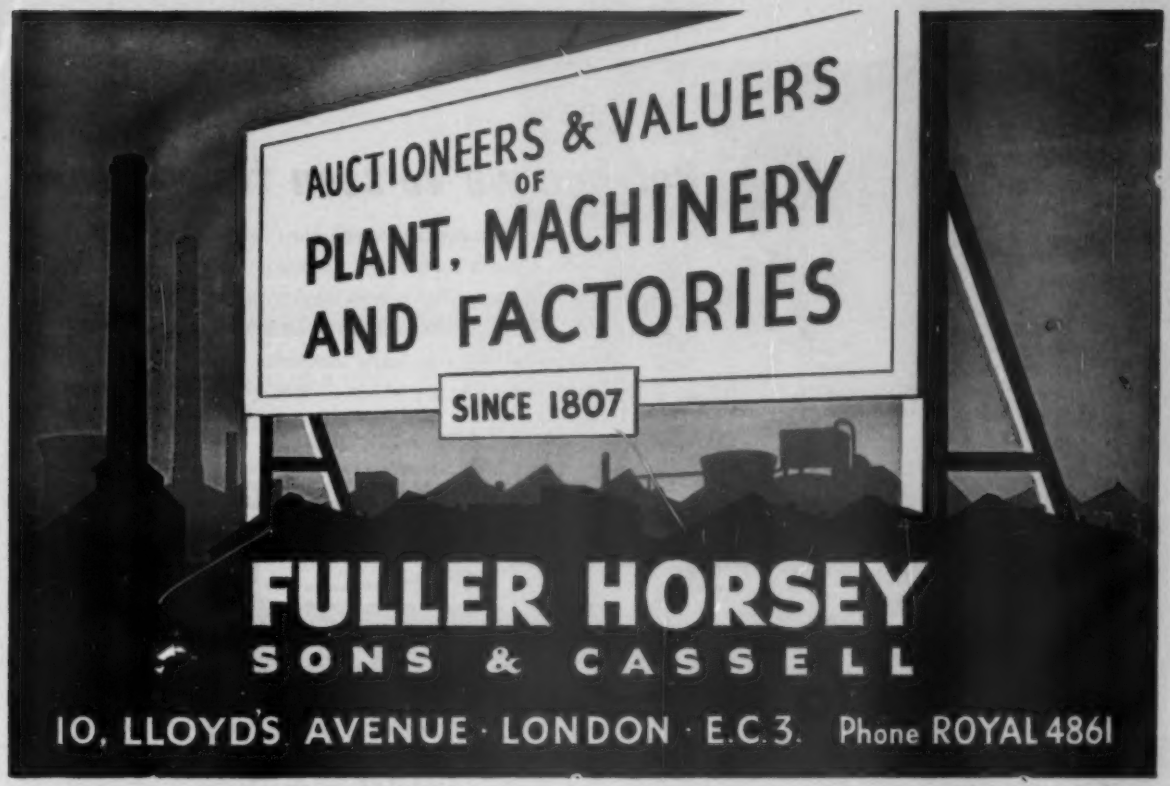

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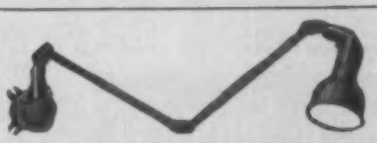

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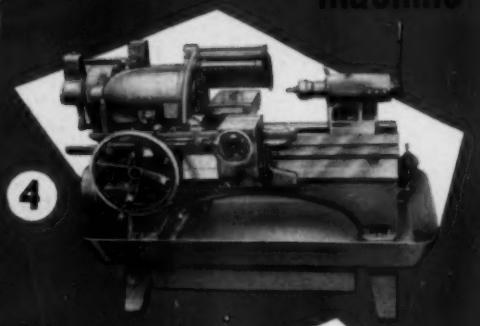

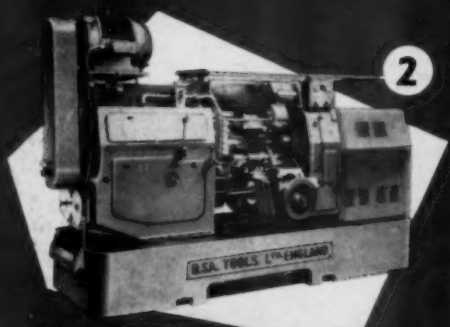

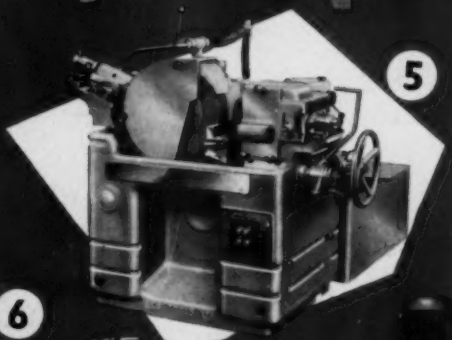

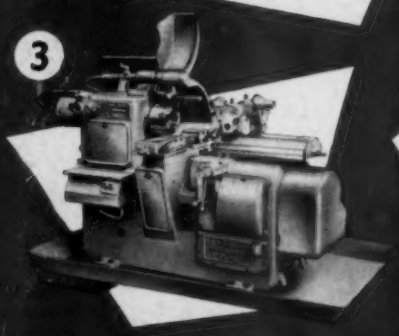

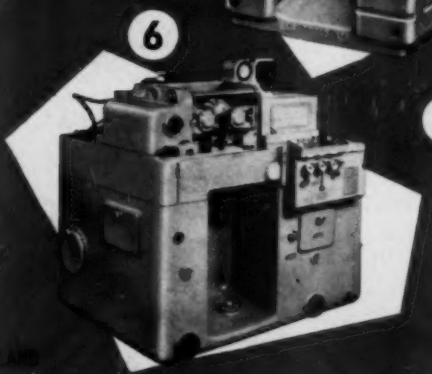

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